

“of the individual life becomes greater, a proportionately smaller number of generations will succeed one another in a given time, and therefore the rate of change that the stock will undergo will be lowered. The same cause may have brought about the extinction of many of the bulky, highly specialized, and presumably slow-breeding groups of animals, such as the Titanotheres, which have been unable to undergo sufficiently rapid modification to enable them to keep in harmony with a changing environment.”

The following papers were read:—

1. Observations on some Mimetic Insects and Spiders from Borneo and Singapore. By R. SHELFORD, M.A., C.M.Z.S., Curator of the Sarawak Museum. With Appendices containing Descriptions of new Species by R. SHELFORD, Dr. KARL JORDAN, C. J. GAHAN, the Rev. H. S. GORHAM, and Dr. A. SENNA.

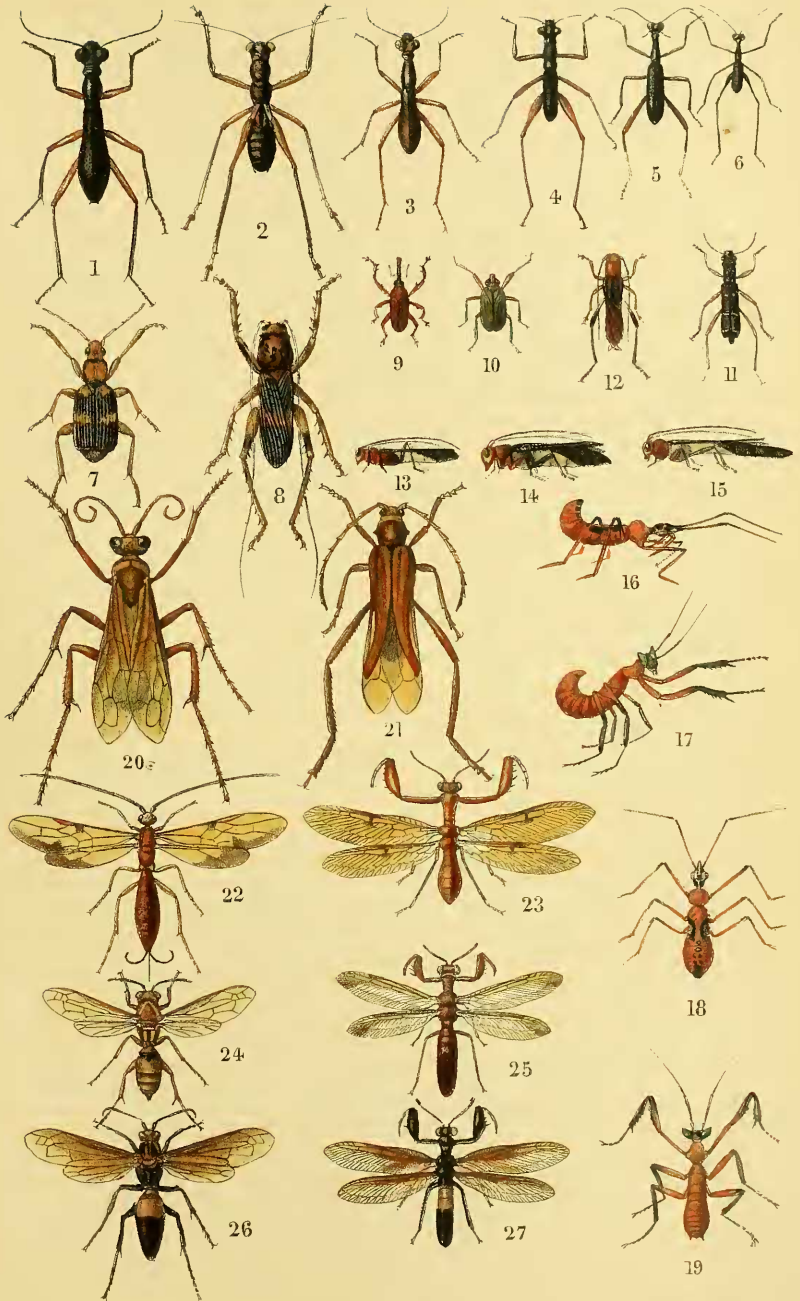
[Received November 13, 1901.]

(Plates XIX.—XXIII.¹)

The theory of mimicry having originated and having been further elaborated chiefly from a study of South American insects, it is but natural that these should figure largely in all works relating to the subject. This paper, a brief abstract of which, arranged by Professor Poulton, appeared in the British Association Reports, 1900, p. 795, is an attempt to bring into greater notice the richness of the Malayan sub-region in similar mimetic species—nearly all the examples here described and discussed having been captured within the last four years in a circumscribed area of 10 mile radius, with Kuching, the capital of Sarawak, as its centre. A recent collecting-trip of three weeks' duration to Mt. Penrissen (about 50 miles inland) was productive of several new examples; and I feel convinced that a similar reward awaits the collector on other mountains of the island and on those of Sumatra, Celebes, and other numerous islands of the great Archipelago, many of which are still virgin ground to the entomologist.

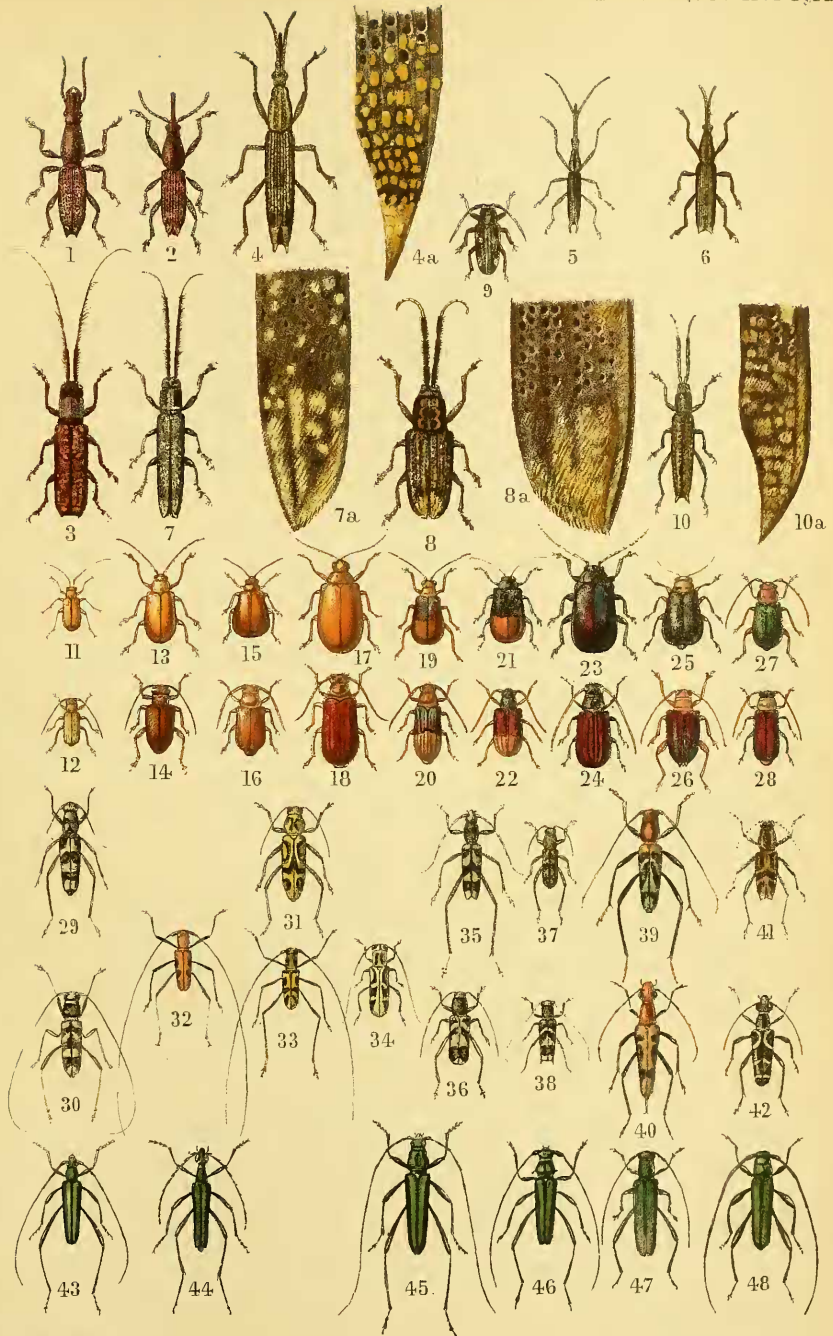
In order to summarize as much as possible our knowledge of the mimetic insects of Borneo, I have drawn up tables of the mimetic Longicorn Beetles and of the Lepidoptera; the latter is a modification of a somewhat similar list given by Haase in his 'Researches on Mimicry' (English translation), Stuttgart, 1896, but I have found it necessary to question certain conclusions and to make a few additions.

¹ For explanation of the Plates, see page 231.



Horace Knight del. et lith.

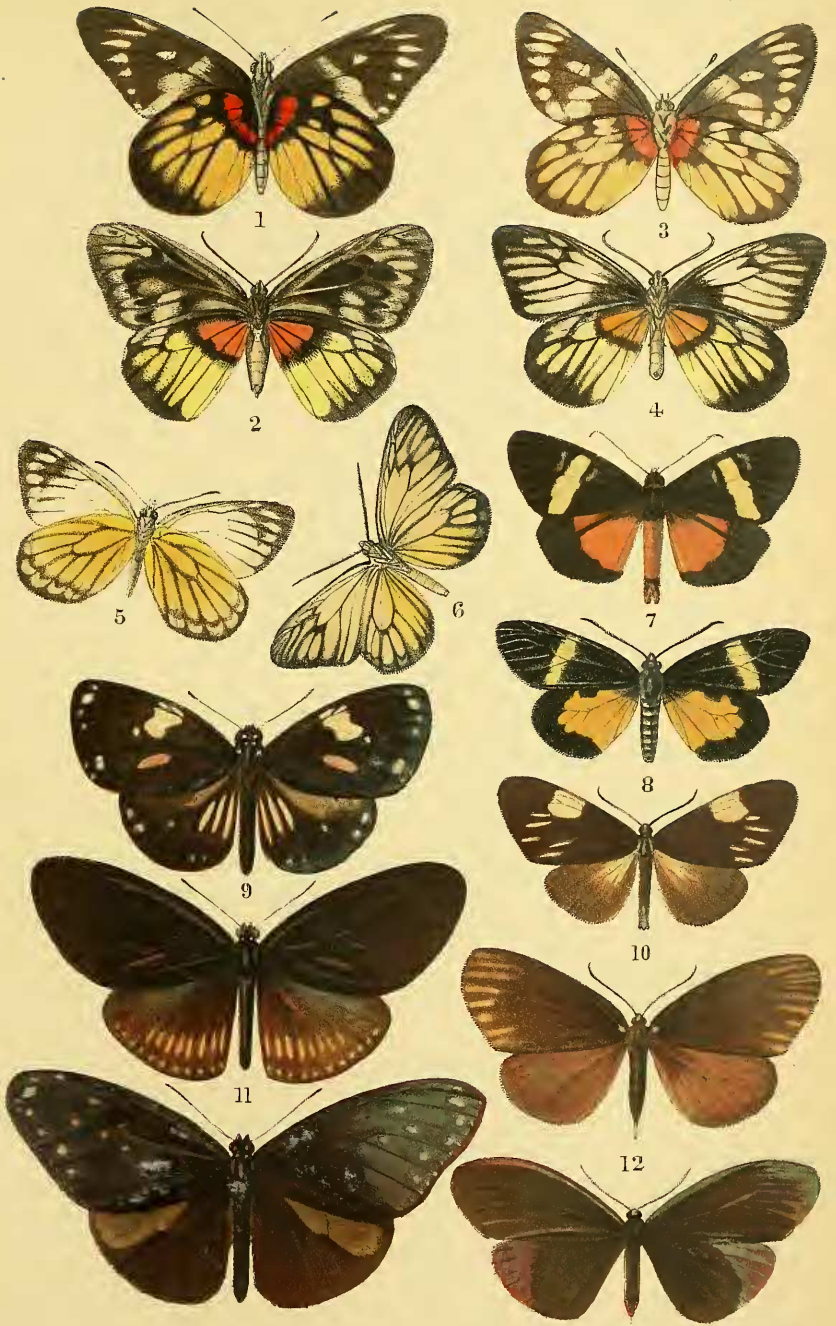
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MIMETIC BORNEAN COLEOPTERA AND THEIR MODELS.



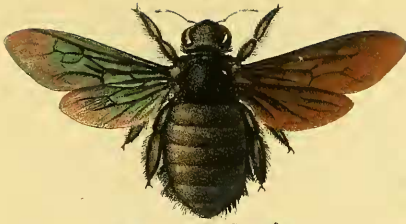
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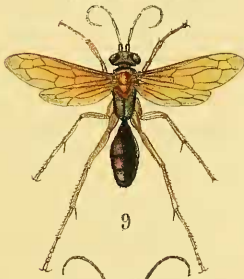
MIMETIC BORNEAN CHALCOSID MOTHS AND THEIR MODELS.



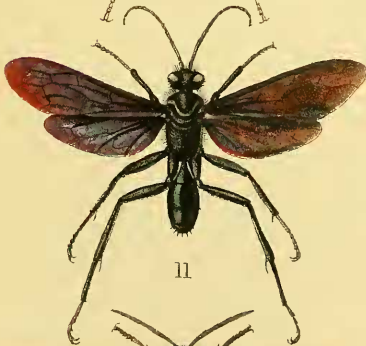
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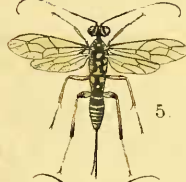
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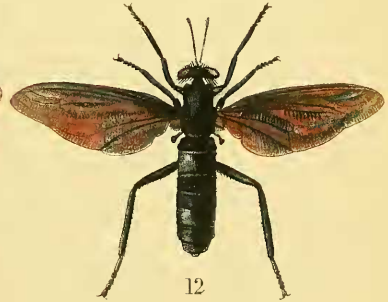
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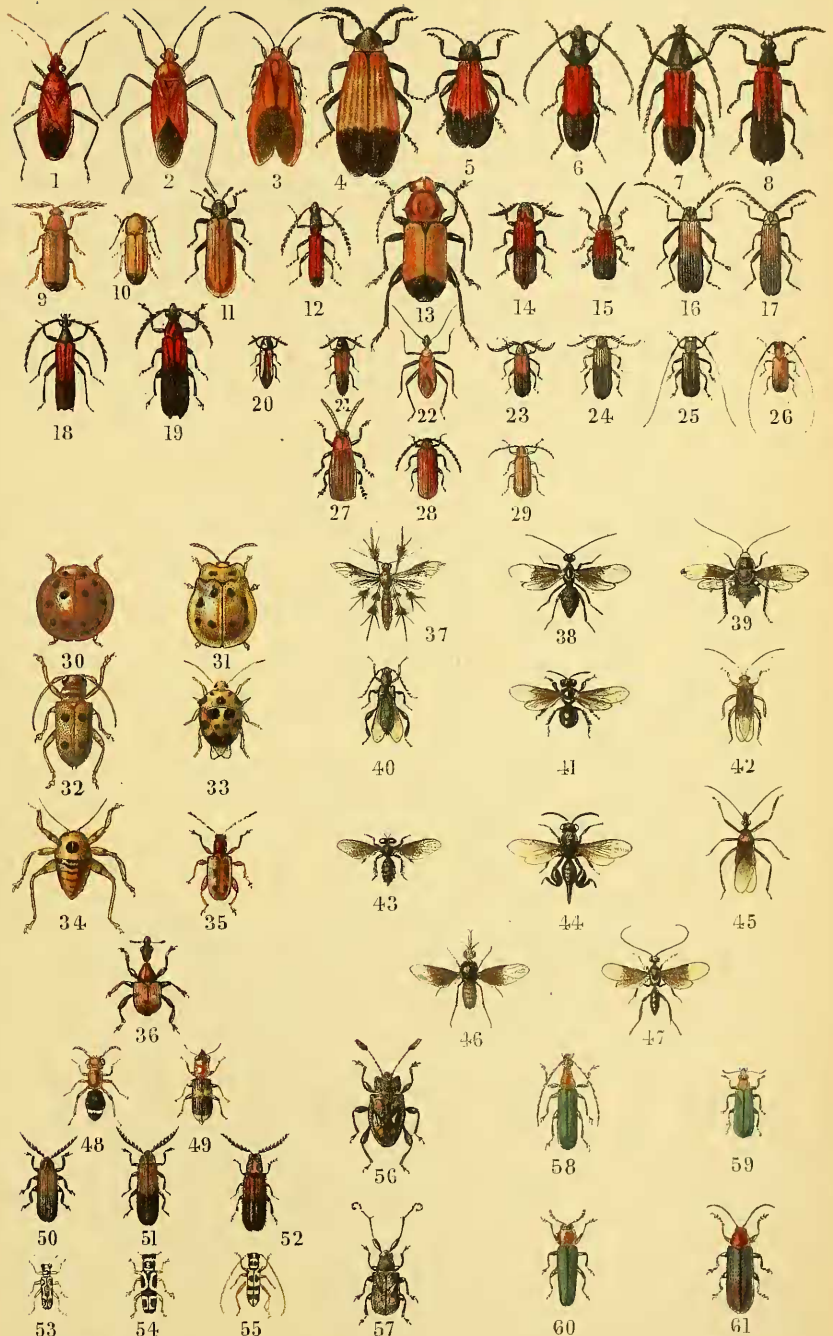
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Horace Knight del. et lith.

Mintern Bros Chromo.

MULLERIAN MIMICRY IN GROUPS OF BORNEAN INSECTS.

It is frequently possible to pair a mimicking species with a definite specific model, but perhaps more frequently the mimic (either a Batesian or a Müllerian mimic) in its general appearance resembles a whole group of known distasteful insects; or, in other words, the general appearance of the mimic is typical of a distasteful group, rather than exactly similar to one definite species; and in these tables of mimetic Longicorns and their models I have by no means included all, but merely typical models.

The diagrammatic tables of convergent groups of pseudo-aposematic and synaposematic insects at the end of the paper include, however, all the known distasteful insects which serve as models in the respective groups.

In the Appendices are described a new species of Butterfly, a new Moth, two new genera and several species of Longicorn Beetles, two new Clerids, and two new Brentheids. I owe the description of all except the first-mentioned species to the kindness of Dr. Karl Jordan, Mr. C. J. Gahan, the Rev. H. S. Gorham, and Dr. A. Senna.

Professor E. B. Poulton, F.R.S., has added some interesting and suggestive remarks on my observations: these are scattered throughout the paper, but in all cases his initials are affixed.

My task, in the absence of a large library and of named collections for comparison and reference, has not been easy, but I have received the most valuable and generous aid from Professor Poulton, whom I feel that I can never sufficiently thank. It is not too much to say that had it not been for his help this paper could not have been written. Most of the specimens here described and figured are now deposited in the Hope Museum, Oxford, where they can be seen by all students of the subject. I am much indebted to Mr. H. N. Ridley, Director of the Botanic Gardens, Singapore, for directing my attention to some interesting cases of mimicry observed by him and for some valuable notes thereon. Mr. Gilbert J. Arrow, Monsieur Jules Bourgeois, Mr. Malcolm Burr, Sir G. Hampson, Dr. F. A. Dixey, Dr. R. Gestro, the Rev. O. Pickard-Cambridge, F.R.S., Mr. R. McLachlan, F.R.S., Mr. W. L. Distant, Mr. C. J. Gahan, Dr. Senna, Mr. M. Jacoby, Col. Bingham, Mr. E. E. Austen, Mr. C. O. Waterhouse, Dr. Brunner von Wattenwyl, and Col. Yerbury have rendered much kind assistance in identifying many of the species noted in this paper, and to these gentlemen I tender my grateful thanks.

I. ORTHOPTERA AS MIMICS.

i. Mimic. Larva of *Hymenopus bicornis* (Stoll).

Plate XIX. figs. 17 & 19. × 2.

Model. Larva of *Eulytes umcæna* (Fab.).

Plate XIX. figs. 16 & 18. × 2.

The newly-hatched larvæ of *Hymenopus bicornis*, one of the

Harpagid Mantidæ, mimic the young larvæ of the Reduviid bug, *Eulyes amoena*, not only in coloration, but also in the peculiar habit of walking about with the abdomen curled over the back (compare figs. 16 & 17). When the young Mantides first emerge from the ootheca they are of a brilliant red colour, the head, basal joint of the antennæ, apices of the femora, and the tibiæ alone being jet-black. A similar arrangement of colours is exhibited by the young of *E. amoena*: in these the head, apices of the femora, bases of the tibiæ, the wing-rudiments, and some spots on the dorsal surface of the abdomen are black, whilst all the rest is vermilion (compare figs. 18 & 19). The newly-hatched larvæ of the bug are very much smaller than the corresponding stage of the Mantis, but after the second moult the size of the former is almost the same as that of their mimics when newly-hatched. The brilliant coloration of the bug is essentially a warning signal, being correlated with an objectionable smell and presumably a still more objectionable taste, judging from the expressions of disgust manifested by two tame monkeys (*Macacus cynomolgus*) after tasting the specimens I offered them. The young *Hymenopus* they had eaten with the utmost sangfroid a few days before, from which one may justly conclude that in this case the coloration is deceptively warning or pseudaposematic (truly mimetic). It is unfortunate that I was unable to rear, or even to keep alive for a few days longer, the young Mantides; but they are notoriously difficult insects to rear, and all my specimens died before I was able to obtain the young of *Eulyes amoena*. The pupa and adult of this species of Mantis are floral simulators: the former resembles a pink *Melastoma*; the latter, which is cream-coloured varied with brown, resembles the flower of an orchid of fairly common occurrence; and I have also seen a young larva which bore a striking resemblance to a small pink flower of an order not known to me. I have had this insect in various stages of its life-history frequently under observation, and can confirm in almost every detail Mr. Annandale's recently published account of the habits of the pupa (*cf.* P. Z. S. 1900, pp. 839 *et seq.*). That the insect should mimic in the youngest stage of its life-history a distasteful and conspicuously-coloured bug is a fact of some interest.

[The late Mr. L. de Nicéville states, in a letter to Prof. Poulton, that he had reared some species of Mantidæ; one species when newly hatched was remarkably like a small black ant, the deceptive resemblance being so close that a careful scrutiny was necessary to determine the exact nature of the insect. Mr. de Nicéville also remarks:—"A Mantis of fair size does not often move but waits for its prey to come to it, but these young ones ran about incessantly looking for their prey, just like the ants they mimicked."]

- ii. **Mimic.** *Condylodera tricondyloides* (Westw.).
Plate XIX. figs. 2, 4, & 6.

Models. *Cicindelidae*. Plate XIX. figs. 1, 3, & 5.

I was fortunate enough to discover in Sarawak the remarkable Locustid, *Condylodera tricondyloides*, originally described in 1837 by Westwood from Java (Trans. Linn. Soc. vol. xviii. p. 409); the type specimen was at first placed by Westwood in his collection of Cicindelidæ, "regarding it as an immature *Collurius* or *Tricondyla*" (l. c. p. 419). Another Javan specimen was actually given the MS. name of *Tricondyla rufipes* by Duponchel, so close is the resemblance of this highly deceptive Locustid to a Tiger-beetle. Both these historical specimens are now in the Hope Collection at Oxford, and have been compared with the Sarawak specimens by Mr. Malcolm Burr.

My first specimen, which is somewhat larger than the type, was found in jungle in the neighbourhood of Kuching, running about on the ground amongst dead leaves and other vegetable debris, an environment much frequented by a large Tiger-beetle, *Tricondyla cyanea* (Dej.) var. *wallacei* (Thoms.), with which this Locustid is almost identical in appearance (compare Plate XIX. figs. 1 & 2). The shape, size, coloration, and even the gait of the mimic so closely resembled the corresponding traits of its model, that I did not suspect the importance of my find till a careful examination of the collecting-box had been made some hours after the time of capture. The colour of the head, thorax, and abdomen of the *Condylodera* is a dark shining blue, the femora of all the legs are red, the hind femora (which are only slightly swollen) having in addition a proximal black band. The head with its large prominent eyes, somewhat flattened face, and conspicuous jaws, is very Cicindelid in appearance. The antennæ are of extreme tenuity and are about $2\frac{1}{2}$ to 3 times as long as the body. The densely-punctured prothorax is globosely swollen about its middle, the swelling being marked off from the elevated anterior border and posterior portion by broad constrictions. The tegminal and wing rudiments lie very closely adpressed to the body and do not disturb the even contour of the dorsal aspect. The abdomen, though hardly so bottle-shaped as are the elytra and abdomen of the model, is not widely different in appearance, and the intersegmental membranes are quite concealed except on the ventral surface, where the scuta are small, as is usual in this group of insects.

The model is so common and so well known a species that it is unnecessary to describe its general appearance; the above brief description of its mimic will suffice to show in how many superficial points the two insects agree, and superficiality of resemblance is the key-note of mimicry.

Another specimen of this mimetic Locustid of the same size was obtained a few months later in the same locality; and both these

are pronounced to be fully adult by that well-known authority on the Orthoptera, Mr. Malcolm Burr.

Bearing in mind the errors made by Westwood and Duponchel with regard to this insect, I made a careful search through the Sarawak Museum collection of Cicindelidæ, and was rewarded by finding yet another example of this remarkable mimic placed amongst specimens of *Tricondyla gibba* (Chaud.), which it most closely resembles as regards size, coloration, &c. The specimen was smaller than those described above and is evidently a younger stage, but it differs in hardly any other way: and *T. gibba*, the model, also differs from *T. cyanea* var. *wallacei* principally in size (compare Plate XIX. figs. 3 & 4).

A fourth specimen, of a very early stage, was taken in Kuching on the flowers of a flowering tree, frequented also by numerous insects of all orders, amongst others being the Cicindelid, *Collyris sarawakensis* (Thoms.), which serves as a model to the young *Condylodera* (Plate XIX. figs. 5 & 6). At this stage, the insect is entirely dark blue, except the legs which are dark brown, and the greater part of the long antennæ which are ochreous, the four basal joints only being blue. The prothorax shows no trace of the conspicuous puncturation of the adult, nor is it swollen as in the later stages, but more or less cylindrical like that of its model; the wing-rudiments are not yet visible, and the auditory organ on the fore-tibiæ can only be distinguished with difficulty. The model is somewhat larger, of a uniform dark blue with the legs dark brown. It is somewhat curious that the young *Condylodera* does not mimic *Collyris emarginata* (Mael.), a smaller species with red legs, especially since in the later stages it is red-legged species of Cicindelidæ that are mimicked; *C. emarginata* is, however, of a much more brilliant blue than any other Bornean members of the genus, or than the species of *Tricondyla*. This case of mimicry appears to me to be of exceptional interest and without a parallel. I have shown that *Hymenopus bicornis*, a floral simulator throughout the greater part of its life, mimics in its young stages the larvæ of a bug; but I know of no ametabolous insect, except *Condylodera tricondyloides*, which mimics different species of one family during the successive periods of its growth.

iii. **Mimic.** *Gryllacris* n. sp. *vicinissima nigratæ* (Br.).

Plate XIX. fig. 8.

Model. *Pheropsophus agnatus* (Chaud.). Plate XIX. fig. 7.

The model in this instance is one of the "Bombardier Beetles," and discharges, when seized or irritated, a jet of formic acid vapour quite powerful enough to scorch the skin of the finger severely and to leave an indelible brown stain on paper or cloth. The insect is quite conspicuous, being black with orange spots on the dorsal surface of the thorax and tegmina; the legs and antennæ are entirely orange. The Locustid is somewhat larger,

and though the markings do not correspond accurately with those of the model, a general resemblance is produced. The head is orange, the prothorax is black with large orange blotches, the tegmina are black with an orange spot at the base of each, corresponding to a similar spot at the base of each elytron of the beetle, and with an orange fascia about the middle, corresponding to a broad orange spot in a similar position on each elytron of the beetle. The legs are banded with orange and black (compare Plate XIX. figs. 7 & 8). The mimic is met with amongst herbage in jungle, and all the examples of the somewhat common "Bombardier" that I have met with were taken in the same environment. The powerful jaws of the larger *Gryllacrides* furnish possibly an efficient protection against the attacks of vertebrate enemies, such as small birds, lizards, and frogs, but in so small a species as this the resemblance to a beetle capable of discharging a scorching jet of formic acid vapour must be a far more efficient means of protection.

iv. **Mimic.** Nov. gen., nov. sp. vicinissima *Gammarelettigi*.
Plate XXIII. fig. 34.

Model. *Coccinellida*. Plate XXIII. fig. 30.

In February 1901 the Museum collectors brought in a small Locustid of a brilliant vermilion colour spotted with black. When the insect was resting the head was bent downwards and almost concealed by the large prothoracic shield, the abdomen was strongly curved downwards and the legs were drawn close up to the body, the long hind tibiae being bent up under their femora: in this attitude the resemblance of the insect to a black-spotted red "ladybird" of a convex shape, e. g. *Caria dilatata* (Fab.), was most striking (compare Plate XXIII. figs. 30 & 34). The eyes are intense black; the large prothoracic shield has three black spots, one central, the others lateral; the segments of the abdomen bear each a small dorsal black spot, decreasing in size posteriorly; the fore- and mid-femora bear outwardly one conspicuous spot, whilst the hind-femora have two such spots.

When touched, this little Locustid did not leap away, as might have been expected, but kept perfectly still, and if further irritated it simply rolled off the surface on which it was resting and assumed a death-like attitude on the ground below, thus simulating very perfectly the habits of a Coccinellid.

I have to thank the distinguished orthopterist Brunner v. Wattenwyl for reporting on this Locustid and the *Gryllacris*.

II. NEUROPTERA AS MIMICS.

i. **Mimic.** *Mantispa simulatrix* (McLachl.). Plate XIX. fig. 23.

Model. *Bracon* sp. Plate XIX. fig. 22.

This case offers an instance of the distastefulness of the Hymenoptera Parasitica, a group mimicked also by insects

belonging to the most diverse orders, such as Hemiptera, Diptera, Lepidoptera, and Coleoptera.

The model is one of those reddish-ochraceous Braconids, of which there are many representatives in Borneo, all being more or less common. This particular species, with a conspicuous black stigma on the fore wing, is eminently a mountain form, as the numerous specimens in the Sarawak Museum bear witness. Mt. Matang at any elevation above 1500 feet is its favourite haunt, but I have never taken it below that altitude. The mimic, which was recently described¹ by Mr. McLachlan, was captured in the month of August also on Mt. Matang, at an altitude of 2500–2800 feet. It, too, is reddish-ochraceous, whilst each wing bears a black stigma, those on the fore-wings being slightly more conspicuous than those on the hind-wings; the sides and ventral surface of the abdomen are pure white (in the fresh condition), so that when the insect is seen in profile its somewhat bulky body appears to be reduced approximately to the size of the body of its model; as, further, the model also has the ventral surface of the abdomen coloured white, the resemblance between the two insects is still greater (compare Plate XIX. figs. 22 & 23). This method of producing a thin-bodied or wasp-waisted effect by white patches is by no means uncommon amongst insects; I shall be able to give further examples of it in this paper (*vide infra*, pp. 238, 241), and at present need only refer to the well-known Soudanese Locustid *Myrmecophana fallax* (Br.) mimicking an ant, and to the Moth *Pseudosphex hyalina* which mimics a Sphex.

ii. **Mimic.** *Mantispa* sp. Plate XIX. fig. 27.

Model. *Polistes sagittarius* (Sauss.). Plate XIX. fig. 26.

The Wasp, *P. sagittarius*, is an extremely common species and is rendered highly conspicuous by reason of a red band on the second abdominal segment; the rest of the body is black, varied on the head and thorax with a rich red-brown; the wings are fuscous, becoming flavo-hyaline outwardly. The mimic is black with the second and third abdominal segments red, the width of these two segments closely corresponding with the large second abdominal segment of the wasp; the wings are hyaline, but largely shaded with fuscous at the base and along the costal margins and flavo-hyaline at the apex (compare figs. 26 & 27). A closely allied species from Assam is in the Hope Collection at Oxford, with the MS. name of *M. nodosa* (Westw.). The specimen belonged to the Cantor Collection.

iii. **Mimic.** *Mantispa* sp. Plate XIX. fig. 25.

Model. *Polistes* sp. near *diabolicus* (Sauss.). Plate XIX. fig. 24.

The general colour of the Wasp is reddish-brown, the abdomen is covered with a fine silky pubescence golden in colour; this

¹ Ent. Month. Mag. (ser. 2) vol. xi. 1900, pp. 127–128.

pubescence is denser at the apices of the segments, forming here narrow yellow bands; the wings are flavo-hyaline, sometimes with a brown stigma.

The mimic is of a reddish hue, the abdomen is a little paler, corresponding to the red-brown seen through the golden pubescence of the wasp's abdomen; the apex of each segment is narrowly banded with yellow. The wings are broadly hyaline along the costal margins and there is a brown stigma. A closely allied species from Celebes is unnamed in the British Museum.

Both this and the preceding *Mantispa* were referred to Mr. R. McLachlan, who pronounced them to be undescribed species.

iv. **Mimic.** *Mantispa* ? *cora* (Newm.).

Model. *Mesostenus* sp.

A small black-and-yellow banded *Mantispa* was caught on the hill, Bukit Timah, at Singapore amongst short undergrowth, and at the same time I took also several specimens of a common Ichneumon-fly very similarly coloured. The *Mantispa* was extremely active on the wing and at first sight almost indistinguishable from its model. I append some colour notes on the two insects:—

Mantispa.—Ground-colour of head, thorax, and abdomen black, the following bands bright yellow—two vertical on the face, one transverse on the vertex, an anterior transverse and three longitudinal on the prothorax, one transverse on both meso- and metathorax, which are ventrally blotched with yellow; abdomen alternately banded black and yellow. Anterior legs yellow blotched with black, mid- and posterior femora broadly banded black and yellow. Bases of wings yellow and a distinct black stigma on the fore wings.

Mesostenus sp.—Head yellow; prothorax black bordered with yellow and with two central yellow stripes; mesothorax yellow with a central black spot; metathorax posteriorly yellow; abdomen banded alternately black and yellow. Legs yellow blotched with black. Anterior wings with a conspicuous stigma.

I subsequently found the same species of *Mantispa* or a close ally in Borneo, frequenting the blossoms of a Hibiscus; the plant was also visited in considerable numbers by a small yellow-and-black *Icaria* and by a similarly coloured ichneumon-fly; a somewhat careful scrutiny was needed to distinguish these insects one from the other.

III. COLEOPTERA AS MIMICS.

I wish especially to acknowledge the kind assistance received from Mr. C. J. Gahan in working out this section of my paper.

Most of my examples are taken from the Longicornia, and I have drawn up tables of the mimetic species of the group occurring in Borneo. I have made these as complete as possible, but there are a few described species which I have not seen and which have

never been figured. Such species have been included in the appended tables, when their descriptions have shown that they do not differ in characters of mimetic importance from the closely allied species with which I am acquainted; in every case these are marked with an asterisk. I have not included a large concourse of species belonging to the subfamilies *Mesosinæ* and *Apomecyninæ*, which present in their general facies a marked resemblance to the Rhynchophora, for, although the tyro in entomology might readily mistake many of these longicorns for Rhynchophorous species, I have, nevertheless, found it quite impossible to pair any one given species with a definite model. The resemblance is in fact, as is so frequently the case, general and indefinite, not special as, for example, in the species of the subfamilies *Astatheine* and *Saperdine*, which mimic for the most part definite species of the Phytophaga. It will therefore suffice if I simply enumerate here those genera of the *Mesosinæ* and *Apomecyninæ* which present most markedly Rhynchophorous features:—

Subfam. *Mesosinæ*:—*Anancylus*, *Planodes*, *Ereis*, *Cacia*, *Mnemea*, *Sorbia*.

All these Coleoptera, more especially *Ereis anthriboides* (Pasc.), have a general resemblance to Anthribidæ.

Subfam. *Apomecyninæ*:—*Cenodocus*, *Synelasma*, *Etaxalus*, *Phesates*, *Praonetha*, *Sybra*, *Ropica*.

These bear a general resemblance to Curculionidæ.

NOTES ON TABLE I.—*Longicorns mimicking Hymenoptera.*

The subfamily *Phytæciinæ* furnishes ten and probably more species belonging to three genera which mimic the Braconidæ. The models can be divided into two sections:—(1) species with dark red head and thorax and black abdomen and wings (genus *Myosoma*); (2) reddish-ochreous species (genus *Iphicaulax*), one of which has already been shown to be mimicked by *Mantispa simulatrix*. *Scytasis nitida* (Pasc.) and four species of *Oberea* are coloured in identically the same way as their models, the red-and-black Braconids. Furthermore, *S. nitida* and three out of the four species of *Oberea* (the exception being *O. rubetra* (Pasc.)) are marked with a large white patch of pubescence on the sides of the first and second abdominal segments, which patches, when the beetle is seen in profile, give an impression of a wasp-like waist, from the posterior end of which the abdomen appears gradually to swell in size. This effect is shown in Plate XIX. figs. 13, 14, & 15, representing respectively *Oberea strigosa* (Pasc.) var., *O. brevicollis* (Pasc.), and *Oberea* probably n. sp. near *strigosa* (Pasc.). The thin waist of the model is not seen from above when the insect is at rest, being hidden by the laid-back wings, and consequently this obviates the necessity of dorsal white patches on the mimic as in the African Locustid *Myrmecophana fallax*, whose model is a wingless ant with an abdominal peduncle plainly

TABLE I.—*Longicorns mimicking Hymenoptera.*

Mimics.		Models.	
Fam. LAMIIDÆ.	Subfam. <i>Phlyctinae</i> .	1. <i>Scytalis nitida</i> * (Pasc.).	Red-and-black Braconidae of the genus <i>Mycosoma</i> .
		2. <i>Obrexia brevicollis</i> (Pasc.) (probably = <i>curvialis</i> (Pasc.)).	
		3. " u. sp. between <i>macilenta</i> (Pasc.) and <i>strigosa</i> (Pasc.).	
		4. " <i>strigosa</i> (Pasc.) var.	
		5. " <i>rubetra</i> (Pasc.).	
		6. " sp. near <i>rubetra</i> (Pasc.) and probably a form of it.	Reddish-ochreous Braconidae of the genus <i>Iphiaulax</i> .
		7. " <i>insoluta</i> (Pasc.).	
		8. " <i>consentanea</i> (Pasc.).	
		9. " probably ♂ <i>consentanea</i> .	
		10. " u. sp.	
		11. <i>Napsarha</i> , n. sp.	
		12. <i>Glenea irstine</i> (Pasc.)	
Fam. CERAMBYCIDÆ.	Subfam. <i>Callichrominae</i> .	13. <i>Nothopeus intermedius</i> (Gahan)	<i>Hylotoma pruinosa</i> (Cann.).
		14. " <i>fasciatipennis</i> (Waterh.)	<i>Salix aurosericeus</i> (Guér.).
		15. " sp. near <i>hemipterus</i> (Fab.)	<i>Mycogonia aviculus</i> (Sauss.)
			" <i>anthracinus</i> (Sm.).
		16. <i>Psenida brevipennis</i> (Gahan)	<i>Mycosoma</i> sp.
Fam. TILLOMORPHINÆ.	Subfam. <i>Necydalinae</i> .	17. <i>Epania singaporensis</i> (Thoms.)	<i>Melipona vitata</i> .
		18. " <i>saravakensis</i> (Thoms.) *	Ants.
		19. <i>Halme cleriformis</i> (Pasc.)	"
		20. <i>Clytelus westwoodi</i> (Pasc.)	"

visible both in a dorsal and a profile view. A species of *Oberea* near *rubetra* (6), and probably a form of it, is really intermediate in character between these two sets of mimics, the elytra being brown anteriorly (basally) and black posteriorly. The remaining species of *Oberea* mentioned in the table mimic the reddish-ochraceous Braconids. *O. insoluta* and the species of *Nupserha* have a pale golden pubescence on the basal abdominal segments, and *O. sp.* (10) has a similarly situated greyish pubescence: in every case this coloration is not so effective as the white patches of *O. brevicollis*, &c.; but these unicolorous *Oberreas* are so much more active on the wing, so much more Hymenoptera-like in their actions when resting on a leaf or twig, than when they are alive one is much more apt to mistake them for their models than their bicolorous congeners. In other words, these unicolorous *Oberreas* compensate for the imperfection (from a mimetic point of view) of their coloration by their close approximation to the actions of their models. *O. consentanea* (8 & 9), *O. sp.* near *rubetra* (6), and *O. n. sp.* (10) have the elytra clothed with a delicate silky-grey pubescence, especially in the posterior two-thirds, the appearance varying according to the position in which the insect is held; and these species mimic Braconids with the outer third of the wings pale fuscous, the varying reflections of the elytra giving a similar impression to that produced by the semitransparent fuscous parts of the model's wings.

Glenea ivesine (Pasc.) is a small blue species; the middle third of the elytra is brown, shading anteriorly into blue, posteriorly into greyish white; the model is a small blue *Hylotoma*, and when the wings are laid back the resemblance between the two species is striking; the blue anterior third of the beetle's elytra corresponds to the posterior part of the *Hylotoma's* thorax, the brown portion to the abdomen with the superposed wings, the greyish posterior third to the tips of the wings of the model, which project beyond the end of the abdomen.

Turning to the family Cerambycidae, we find that the subfamilies *Callichrominae* and *Necydalinae* present in the reduction of the elytra a marked Hymenopterous appearance. *Nothopeus fasciatipennis* (C. O. Waterh.) has already been figured and described (Trans. Ent. Soc. 1885, p. 369, pl. x.). *Nothopeus sp.* near *hemipterus* (Fab.) is a large black species with entirely fuscous wings, and is an admirable mimic of a formidable wasp, *Mygnumia anthracinus* (Sm.), which occurs commonly on Mt. Matang. The buzzing flight and other movements of these two *Nothopei* are remarkably wasp-like and so completely deceived the Museum collectors that they employed the greatest precautions in transferring the specimens from the net to the killing-bottle.

A magnificent new species, described by Mr. Gahan in Appendix II. as *Nothopeus intermedius* (Plate XIX. fig. 21), was captured near the summit of Mt. Penrissen together with several of its models, *Salix aurosericeus* (Guér.) (Plate XIX. fig. 20).

The general colour of the beetle is reddish ochreous, the prothorax is clothed with a fine golden pubescence; the prominent black eyes, the somewhat flattened antennæ, and long hind legs closely correspond with the same organs of the *Salix*; further, the elytra, though not shortened, are much reduced in width, rapidly narrowing from a breadth of 3.5 mm. at the base to 1 mm. at the apex, so that the clear golden wings are very imperfectly hidden and add not a little to the general wasp-like appearance. When seized, this beetle curved down its abdomen in the most characteristic wasp-like manner, and it was only with the greatest reluctance and most careful precautions that my Dyak collectors, to whom I pointed out the insect, captured it. As in the *Obereas*, no representation has here been made in dorsal view of the wasp-waist of the model, and for the same reason, namely, that this is hidden, when the *Salix* settles, by its wings, and it is only at such periods of rest that the full effect of the deceptive resemblance can be appreciated; that part, however, of the first abdominal segment of the *Nothopeus* which is visible from the side and below is clothed with a golden-grey pubescence, which produces the same effect as in the *Obereas*.

It is possible that this species of *Nothopeus* is itself distasteful like the mimicked genera *Chloridolum* and *Leontium* (see later), but I could distinguish no pungent odour like that emitted by those genera, and I am inclined to think that its mimetic resemblance is its sole defence.

I have lately become acquainted with a mimetic species belonging to the subfamily *Necydalinæ* (Plate XIX. fig. 12, no. 16 in Table I.), described in Appendix II. as *Pseberia brevipennis*, and I therefore add some details of its habits and of the mode in which the mimetic resemblance is attained. The species in question mimics with a remarkable degree of accuracy one of the common red-and-black Braconidæ: these Hymenoptera, as already shown, serve as models to a considerable number of species of *Oberea*, but in none of these latter is a Hymenopterous appearance so admirably borne as in this, a member of a subfamily for the most part characterized by a reduction of the elytra. The head and prothorax are of an Indian red, the wings are purplish-black, the two anterior pairs of legs are testaceous, the long slender posterior pair black with the bases of the femora white; the body is so slender that the necessity of producing a wasp-waisted effect by means of lateral white patches, as in some of the above-noted *Obereas*, can be dispensed with.

Most of the life of this beetle, as in all Longicornis with reduced elytra, is spent on the wing, when it is simply indistinguishable from its model; when it comes to rest the resemblance is still remarkably exact, and its quick restless movements and habit of flickering the antennæ in all directions are very Bracon-like. No specimen at all resembling this remarkable species has hitherto existed in the British Museum.

Of the *Necydalinæ*, one species *Epania singaporensis* (Plate Proc. Zool. Soc.—1902, Vol. II. No. XVI. 16

TABLE II.—*Longicornus mimicking other Coleoptera.*

Mimics.		Models.	
Subfam. <i>Mesostinae.</i>	1. <i>Elictea concinna</i> (Pasc.)	<i>Arrhenodes</i> sp.	Fam. BRENTHIDE.
	2. <i>Zelota spathomelina</i> (Gah.)	<i>Spathomeles</i> sp. near <i>turritus</i> (Gerst.).	Fam. EXDOMYCHIDE.
	3. <i>Trachystola granulata</i> (Pasc.)	<i>Sipalus granulatus</i> (Fab.).	Fam. CURCULIONIDE.
Subfam. <i>Hippopsinae.</i>	4. <i>Alibora</i> sp.	<i>Baryrhynchus debiscens</i> (Sch.).	Fam. BRENTHIDE.
	5. <i>Egoprepis insignis</i> (Pasc.)	<i>Litarus sylvanus</i> (Senna).	
	6. <i>Ectatostia moorei</i> (Pasc.)	" <i>shelfordi</i> (Senna).	
	7. <i>Dymacenus porosus</i> (Pasc.)	" <i>forcipatus</i> (Westw.).	
	8. <i>Stegenus dactylon</i> (Pasc.)	" <i>sylvanus</i> (Senna).	
Subfam. <i>Agathinae.</i>	9. <i>Entelopes glauca</i> (Gnér.)	Coccinellid, e. g., <i>Caria dilatata</i> (Fab.).	Fam. COCCINELLIDE.
	10. " " near <i>atlaccai</i> (Pasc.)	<i>Metricoides apicalis</i> (Jac.) var.	Fam. GALERUCIDE.
	11. " " <i>ioptera</i> (Pasc.)*	<i>Carilleca</i> sp. near <i>mouhoti</i> . Perhaps variety only.	
	12. " " <i>amena</i> (Pasc.)	<i>Aulacophora boisduvali</i> (Baly).	
	13. <i>Sericaria aurulenta</i> (Pasc.)	<i>Ænidia</i> sp.	
	14. " " <i>prolata</i> (Pasc.)		
	15. <i>Xyaste invida</i> (Pasc.)	<i>Melampyrus acutangulus</i> (Bourg.).	
	16. " " <i>torrida</i> (Pasc.)	<i>Dittonices</i> sp. near <i>fuscicornis</i> (Gorb.).	
	17. " " <i>funosa</i> (Pasc.)	Same model as 15.	

- 18. *Astathes unicolor* (Pasc.)
- 19. " *posticatus* (Thom.)
- 20. " *flaviventris* (Pasc.)
- 21. " *splendida* (Fab.)
- 22. " *caloptera* (Pasc.)
- 23. *Tropimetopa simulator* (Pasc.)
- 24. *Ochrocecis enanida* (Pasc.)
- 25. *Chreonoma*, n. sp.
- 26. " *tabida* (Pasc.)

Subfam.
Astathinae.

- 27. *Daphisia pulchella* (Pasc.)

Subfam.
Physectinae.

- 28. *Ephies dilaticornis* (Pasc.)

Subfam.
Lepturinae.

- 29. *Erythrus apiculatus* (Pasc.) var.
- 30. " *rotundicollis* (Gahan)
- 31. " *sternalis* (Gahan)
- 32. " *biapicatus* (Gahan)
- 33. *Pygrestes eximius* (Pasc.)

Subfam.
Pygrestinae.

- 34. *Erythrus viridipennis* (Gahan)

Subfam.
Sesigrinae.

- 35. *Collyroides lacordairei* (Pasc.) *

Subfam.
Clytinae.

- 36. *Scalathrus amoenus* (Gory)

- Antipha* sp.
- " probably *nigra* (Ahl.) var.
- " *abdominatis* (Jac.)
- Caritheca mouleti* (Baly)
- Haplosmyg albicornis* (Wied.)
- Metrioidia apicatus* (Jac.)
- Hoplasona unicolor* (Ill.) var.
- Zabidia* sp. near *laeta* (Baly)
- Anacaphora lateicornis* (Fab.)

Fam.
GALERUCIDÆ.

- Callimerus bellus* (Gorb.)
- " *catenatus* (Gorb.)

Fam. CLERIDÆ.

- Metriorrhynchus kirschi* (C. Waterh.)

- Lycostomus gestroi* (Bourg.)

Fam.
LYCIDÆ.

- " "
- " "
- Metriorrhynchus kirschi* (C. Waterh.)
- dispar* (C. Waterh.)
- " "

- Prionocerus ceruleipennis* (Perty)

Fam. MELYRIDÆ.

- Collyris* sp.

Fam.

- Tricondyla gibba* (Chand.), var. *cyanipes*.

CICINDELIDÆ.

XXIII. fig. 40, no. 17 in Table I.), with its swollen pedunculate posterior femora and white-tipped wings, resembles very closely the common little Dammar-bee *Melipona vidua* (Lepel.) (Plate XXIII. fig. 41); it is remarkably active on the wing and has doubtless often been passed over by collectors, the least important of its foes. *E. sarawakensis* (18) Wallace found crawling on timber, and stated "that they were remarkably ant-like"; in this species the posterior femora are not swollen.

Of the *Tillomorphinæ*, *Clytellus westwoodi* (20) and *Halmecleriformis* (19) are almost indistinguishable from ants.

NOTES ON TABLE II.—*Longicornis mimicking other Coleoptera.*

Excluding, for reasons already mentioned, the subfamilies *Mesosinæ* and *Apomecyninæ*, it will be seen that the *Saperdinæ* and *Astatheineæ* are essentially the mimetic subfamilies in this section. Most of the species are extremely common and highly conspicuous, and I have little doubt but that all are distasteful, and therefore furnish examples of synaposematic coloration (Müllerian mimicry). All the species of the genus *Entelopes* are mimetic. *E. glauca* (Guér.), red with black spots (Plate XXIII. fig. 32), is quite Coccinellid in appearance (compare fig. 30), though more by virtue of its markings than of its shape. This association of red colour with black spots is so typically a warning coloration, as exemplified by scores of species of Coccinellidæ, that it is impossible to regard the same pattern on a Longicorn as anything but pseudaposematic or synaposematic. *Entelopes* n. sp. near *wallacei* (Pasc.), an entirely reddish-fulvous species, has as its model similarly coloured species of the family Galerucidæ, *Metricoidea apicalis* (compare figs. 13 & 14, Plate XX.), which, as will be seen, serves also as model for two species of the *Astatheineæ*. *Entelopes ioptera* (Pasc.), with its yellow prothorax and blue elytra, and *Entelopes amoena* (Plate XX. fig. 26), with reddish prothorax and blue elytra, also find parallels amongst the distasteful Galerucidæ (see the accompanying Table, pp. 242, 243; also Plate XX. fig. 25). *Serixia modesta* (Pasc.) and *S. lychnura* (Pasc.) are unlike any distasteful species with which I am acquainted; the closely-allied *S. prolata* (Plate XX. fig. 12) and *S. aurulenta* (Pasc.) mimic a small reddish-fulvous Galerucid, *Anidia* sp. (Plate XX. fig. 11). The genus *Xyaste* is interesting as it mimics beetles of quite a different nature—the Lycidæ, whose distastefulness I have proved by repeated trials with various small mammals and birds. *Xyaste* is generically separated from *Serixia* by the thickened and pilose basal joints of the antennæ; the remaining joints, being of exceeding fineness, are more or less inconspicuous; and it is by this means that the thickened, flabellate, and short antennæ of the Lycidæ are simulated, whilst *Ephies dilaticornis* (Plate XXIII. fig. 18) and *Erythrus apiculatus* var. (Plate XXIII. fig. 8), also mimetic of Lycidæ, have the antennæ shortened and dilated in almost the same manner as their

models. *Xyaste invida* (Plate XXIII. fig. 26) and *X. fumosa* (Plate XXIII. fig. 25) are black with the basal half of the elytra reddish; a similarly coloured Lycid model, *Melampyrus acutangulus* (Bourg.) (Plate XXIII. fig. 23), is common round Kuching. *X. torrida* (Pasc.) is brownish-testaceous with a corresponding brownish-testaceous model—*Ditoneces* sp. (Plate XXIII. fig. 29). Of the Astatheineæ, *Astathes unicolor* (Pasc.) (= *coccinea* Pasc.), a large species with purplish reflections on the elytra (Plate XX. fig. 18), has unmistakable models in similarly coloured Galerucidæ—*Antipha* sp. and *Ochralea nigripes* (Plate XX. fig. 17). The next three species—*A. posticalis* (Plate XX. fig. 22), *A. flaviventris* (Pasc.), *A. splendida* (Plate XX. fig. 20)—all closely resemble each other, being dark shining blue anteriorly, red posteriorly; *flaviventris*, as its name signifies, has a yellow abdomen, whilst *splendida* has a red head and prothorax. The latter species mimics an equally resplendent Galerucidæ—*Caritheca mouhoti* (Plate XX. fig. 19), and the slight differences between *A. flaviventris* and *A. posticalis* are paralleled in two closely-allied Galerucidæ—*Antipha abdominalis* (Jac.) and *A. ?nigra* (Alld.) var. (Plate XX. fig. 21), the former of which alone has a yellow abdomen. *A. caloptera* (Pasc.), a blue species, finds a model in *Haplosonyx albicornis* (Wied.) (compare figs. 23 & 24, Plate XX., and see explanation of this Plate for a few further examples given in Table II. but not again mentioned in the text).

The remaining genera of the subfamily, as represented in Borneo, have corresponding models, also among the Galerucidæ, the resemblance between *Ochrocesis evanida* (Pasc.) and its model, *Hoplasoma unicolor* (Ill.) var. *ventralis* (Baly), being very exact. All these genera—*Tropimetopa*, *Chreonomia*, and *Ochrocesis*—are unicolorous, and form with the unicolorous *Saperdina* and numerous¹ Galerucidæ and Halticidæ a large group of similarly coloured beetles, all of which I consider to be distasteful.

The subfamily *Hippopsincæ* contains four species, each mimetic of a species of the Rhynchophorous family Brenthidæ. The first, *Alibora* sp., mimics *Baryrrhynchus dehiscens* (Sch.) (compare fig. 3 with 1 & 2, Plate XX.). The general colour of both model and mimic is a rich chestnut-brown, variegated on the elytra with bright yellow streaks and spots; the three basal joints of the antennæ of the Longicorn are clothed biramously with long and close-set hairs. In the natural attitude the elongated scapes are closely pressed together, the remaining joints gradually diverging, the result being a remarkable resemblance to the head with its elongated rostrum and shorter antennæ of the Brenthid, which only a closer examination proves to be deceptive; the short legs of the mimic add still further to the resemblance.

All the other three species of *Hippopsincæ* mimic extremely common species of the Brenthid genus *Diurus* (Plate XX.

¹ I have not included in the table all the unicolorous Galerucidæ and Halticidæ with which I am acquainted; those that are included are merely typical examples.

figs. 4, 5, 6). The Brentheids are extremely variable in both sexes, in the matter of size, in the shape and length of the terminal processes of the elytra, and in the amount of scaling on the head and antennæ. The three species here noted range in length from .75 in. to 1.5 in.; and it is of exceptional interest that three mimetic Longicorns of sizes corresponding closely to these forms should be found in a more or less closely circumscribed area, and all belonging to the same subfamily.

In the first couple *Diurus sylvanus* (Senna) (a female) measures 1.5 in. in length, and the mimic *Ægoprepis insignis* (Pasc.) is of corresponding length (compare figs. 4 & 7 on Plate XX.). Both species are dark brown, relieved with pale ochreous streaks and spots; the Brenthid has the prothorax and elytra densely and deeply punctured, the punctures on the elytra being arranged in close-set rows. Both on the prothorax and elytra each puncture is occupied by a peculiar scale, lenticular in shape and pale ochreous in colour; these produce the pale ochreous streaks characteristic of the beetle (fig. 4a). The head and antennæ are covered by similar scales, more closely set and not imbedded in punctures; each elytron terminates in a somewhat sharp point, the homologues of the long, narrow, terminal processes of the male.

The mimic has the ground-colour of the prothorax and elytra black, and their dorsal surfaces are covered with tufts of a fine pale ochreous pubescence (fig. 7a); these represent very well the scales of the Brenthid, and a very similar mottled appearance is thus produced in both species by totally different means. The elytra of the Longicorn do not terminate in sharp points corresponding to the points of the Brenthid's elytra, as in the two species mentioned below. The rostrum of the model is slightly longer than in *Baryrhynchus dehiscens*, but the antennæ are shorter and thicker; and similarly we find that the antennæ of the mimic, which, when carried in the natural attitude (*i. e.*, pointing forward and closely apposed), simulate the rostrum and antennæ of the Brenthid, are plumose for a greater part of their length than in *Alibora* sp., whilst the free portion is short and thick, not long and setaceous as in the *Alibora*. Both model and mimic were taken on a fallen log close together.

Ectatosia moorei (Pasc.) is a mimic of *D. shelfordi* (Senna) (♀), a species of medium size, 1 inch in length (compare fig. 10 with 6 and 10a with 4a on Plate XX.). The simulation is as perfectly carried out and by the same means as in *Ægoprepis insignis*, with this addition, that the elytra terminate in sharp points corresponding to the same points in the Brenthid. The length of the mimic from elytra tips to termination of the plumosity of the antennæ is approximately the same as the length of the model from elytra tips to tip of the rostrum.

Another and a smaller species, *Dymascus porosus* (Pasc.) (Plate XX. fig. 9), mimics—again by the same means—a small *Diurus forcipatus* (Westw.) measuring only .75 inch in total length

(fig. 5). The model may be a male or female, as in such small-sized specimens the male does not bear the long elytral processes characteristic of large or medium-sized varieties, the elytra are merely produced into short points; these short points are mimicked by the Longicorn very exactly.

Stegenus dactylon (Pasc.) of the subfamily *Agniinae* is also a fair mimic of a large-sized *Diurus sylvanus* (compare figs. 8 & 4 on Plate XX.). As in *Egoprepis insignis*, the body is blackish-brown streaked with a pale ochreous pubescence (fig. 8 a); the basal two-thirds of the antennæ are clothed with a dense black plumosity; the remaining joints are ochreous and pale in colour.

Elelea concinna (Pasc.), one of the *Mesosinae*, also mimics in the same manner a small Brenthid, *Arrhenodes* sp., as previously noted by Wallace, who remarks that it carried its antennæ "straight and close together, appearing like a Brenthid."

Another of the *Mesosinae*—*Zelota spathomelina* (described by Mr. Gahan in Appendix I. to this memoir)—mimics an Endomychid, a species of *Spathomeles* near *turritus* (Gerst.) (compare figs. 57 & 56, Plate XXIII.). The model, which is not represented in the British Museum collections, is pitchy-black with two reddish spots on each elytron; springing from each elytron is a stout spine directed somewhat forwards, forming a very efficient defence against the attacks of enemies. It is not improbable, moreover, that this beetle is still further protected by some distasteful properties, which, at any rate, are possessed by the species of the genus *Eumorphus* of the same family, an assemblage of black or purplish insects with conspicuous yellow spots. All of these possess a very pungent though not altogether disagreeable odour, whilst many exude a yellowish acid fluid when seized. The mimic of the *Spathomeles* is coloured in much the same way as its model: on each elytron there is a mamilliform prominence, from which springs a pointed tuft of delicate hairs, which is curved slightly forwards. These tufts so closely resemble the formidable spines of the model that a near inspection with lens and finger is necessary to reveal the deception. Another Endomychid beetle, *Amphisternus mucronatus* (Gerst.), is also a probable model of the same species of Longicorn.

The aberrant *Trachystola granulosa* (Pasc.), which was placed provisionally in the subfamily *Dorcadioninae*, with its deeply punctured and granulate elytra, presents the general appearance of a large black Curculionid, such as *Sipalus granulatus* (Fab.), without, however, exhibiting any very highly modified mimetic characteristics, as in the species previously discussed.

Daphisia pulchella (Pasc.) is a highly conspicuous little beetle of the subfamily *Phytocinae*, and is almost indistinguishable from two species of Clerid of the genus *Callimerus* (compare fig. 55 with figs. 53 & 54 on Plate XXIII.).

[The resemblance of the Cleridæ as a group to widely different Coleoptera and to insects of other orders is well known. Looking

through the fine collection in the Hope Department, two chief types of deceptive coloration were seen to be predominant, viz., that of Mutillidæ and Cantharidæ. While the constant repetition of a single very distinctive Hymenopterous type is remarkable, it must not be forgotten that the Cantharid appearance, orange with black transverse bands, is furthermore strongly suggestive of one of the commonest and most conspicuous types of colouring in the Hymenoptera Aculeata. In addition to these predominant types other deceptive resemblances were common, viz., to Phytophaga, Lycidæ, ants, and apparently, in the case of certain Australian species, to Cetoniidæ. All the species of the interesting genus *Allochotes* (Westw.) were Coccinelliform. The interesting question arises as to whether these resemblances are Batesian (pseudaposematic) or Müllerian (synaposematic). The latter interpretation is strongly supported by the interesting discovery by Mr. Shelford of the mimicry by the Longicorn *Daphisia* of two species of the Clerid genus *Callimerus*, possessing an independent warning coloration. The conspicuous appearance, abundance, and habits of the species of this genus are entirely consistent with the explanation of their colours and pattern as aposematic. Fig. 49 on Plate XXIII. shows a Clerid, *Tillicera* sp., resembling a Mutillid, near *Urania* (Sm.) (fig. 48); fig. 52 a Clerid, *Tenerus sulcipennis* (Gahan), resembling a Lycid, *Metriorrhynchus atrofuscus* (fig. 50 & 51); while figs. 53 and 54 show the Clerid species of *Callimerus* resembled by the Longicorn. The whole group was obtained by Mr. Shelford from the vicinity of Kuching, and it strongly suggests that the Clerid mimics (figs. 49 & 52) are really synaposematic.—E. B. P.]

In the Cerambycidæ, *Collyroides lacordairei* (Pasc.) is the most remarkable mimic of the Cicindelan genus *Collyris*. *Sclethrus amœnus* (Gory) is also remarkably like the genera *Tricondyla* and *Collyris* with its dark blue body and bright red legs, of which the hind pair are considerably elongated (compare fig. 11 with 5 and 3 on Plate XIX.). It is much less common than its model, but is found in the same situations and always tries to escape its captor by running swiftly just like the *Tricondyla*. The other five species mentioned in this section of the table, *Ephies dilaticornis* (Pasc.), the three species of *Erythrus*, and *Pyrestes eximius* (Pasc.), mimic species of the Lycidæ (see group of figs. 4 to 8, 12, 19, Plate XXIII.). *P. eximius* with its elongated prothorax is perhaps less Lycid in appearance than the other species.

Erythrus viridipennis, with black head, red thorax, and green elytra, is a mimic of one of the Melyridæ, similarly coloured, *Prionocerus cœruleipennis* (Perty) (Plate XXIII. figs. 58 & 59). All these species of *Erythrus* were taken in great abundance on Mt. Matang, and I am strongly of opinion that the entire subfamily *Pyrestinae* is a distasteful one: the mimicry in this case is therefore Müllerian. *Ephies dilaticornis*, on the other hand, I am inclined to regard as a Batesian mimic; it is rare, a closer mimic, and belongs to an essentially mimetic subfamily (*cf.* Table III.).

TABLE III.—*Longicornis* mimicking *Longicornis*.

Mimics.		Models.		
Fam. LAMIIDÆ.	Subfam. <i>Acanthochilinae</i> .	{ 1. <i>Driopea clytina</i> (Pasc.)*	<i>Clytanthus</i> sp.	
	Subfam. <i>Laminae</i> .	{ 2. <i>Cylindropygus peregrinus</i> (Pasc.)	<i>Xylotrechus pedestris</i> (Pasc.)	
		{ 3. " <i>comis</i> (Pasc.) & sp. near it	<i>Chlorophorus (Clytanthus) annularis</i> (Pasc.)	
		{ 4. Gen. ? and sp. ?	<i>Chloridolum thomsoni</i> (Pasc.) & sp. near it.	
	Subfam. <i>Phylactinae</i> .	{ 5. <i>Daphisia</i> sp.	<i>Chlorophorus annularis</i> (Pasc.)	
		{ 6. " sp.	<i>Demona viverra</i> (Pasc.)	
		{ 7. <i>Ossolis clytomina</i> (Pasc.)	<i>Clytanthus sumatrensis</i> (Lap. & Gor.)	
		{ 8. <i>Cryllis elyptoides</i> (Pasc.)	" "	
		{ 9. <i>Chlorisanis viridis</i> (Pasc.)*	<i>Chloridolum thomsoni</i> (Pasc.) & sp. near it.	
	Subfam. <i>Geminae</i> .	{ 10. <i>Xystrocera atcynea</i> (Pasc.)	<i>Chloridolum thomsoni</i> (Pasc.) & sp. near it.	
		Subfam. <i>Disteinae</i> .	{ 11. <i>Psalanta chalybeata</i> (Pasc.)*	<i>Chloridolum</i> sp.
			{ 12. <i>Leptura</i> probably n. sp.	<i>Chloridolum cinnyris</i> (Pasc.)
	Subfam. <i>Lepurinae</i> .	{ 13. " sp. near <i>histrionica</i> (Pasc.)	<i>Xylotrechus decoratus</i> (Pasc.)	
		{ 14. " sp.	<i>Demona unistela</i> (Pasc.)	
	Subfam. <i>Glauceinae</i> .	{ 15. <i>Polyphida clytoides</i> (Pasc.)*	<i>Demona viverra</i> (Pasc.)	
Fam. CERAMBYCIDÆ.				

Subfam.
Clytinae.

Subfam.
Callitrominae.

Subfam.
Clytinae.

Subfam.
Callitrominae.

Subfam.
Clytinae.

In the Cerambycidae, the antennae present great diversity of form—flabellate in *Cyriopalus*, thickened in *Epipedocera* and *Ephies*, short in *Demonax*, *Clytus*, and many other genera, enormously elongate in *Neocerambyx weas*; and we find, perhaps as a consequence of this plasticity of the antennal form, a close resemblance in structure and external appearance between the antennae of the mimetic Cerambycidae and their models (*e.g.*, compare antennae of *Nothopeus intermedius* and *Ephies dilaticornis* (Pasc.) with the antennae of *Salix aurosericeus* and the Lycid *Metriorrhynchus kirschi* (C. Waterh.) respectively): whereas in the family Lamiidae, nearly all the members of which are characterized by setaceous or linear antennae, the simulation of the differently constructed antennae of their models, if attained at all, is not brought about by actual resemblances in form, but by such devices as pilosities, modes of holding, or the thinning away of a portion of the length until it becomes almost invisible in comparison with a specially thickened portion (compare the antennae of *Alibora*, *Egoprepis*, &c., and of *Xyaste invida* with those of their respective models).

NOTES ON TABLE III.—*Longicorns mimicking Longicorns.*

The only two subfamilies of the Longicornia which serve as models to the other subfamilies are the *Callichrominae*, a group of metallic-green beetles protected by a powerful odour, which is produced by glands behind the metasternum opening to the exterior by two pores, and the *Clytinae*. This latter subfamily includes the well-known *Clytus arietis* (L.), mentioned in many works on natural history as mimetic of a wasp. Whether this is a case of Müllerian or of Batesian mimicry can only be proved by experiment, but I am quite confident that the Bornean representatives of the group are all highly distasteful. The extremely conspicuous and strikingly coloured *Chlorophorus (Clytanthus) annularis* (Plate XX, fig. 31) was the commonest beetle on Mt. Penrissen at all elevations: some shrubs simply swarmed with it, while its movements and its very presence in such numbers spoke eloquently of some protective characteristic. Species of the genus *Demonax* were almost equally common on the mountain, whilst around Kuching the species *Clytanthus sumatrensis* (Plate XX, fig. 37) and *Demonax viverra* (Plate XX, fig. 35) are amongst the commonest Longicorns met with. Such few experiments as I have conducted have yielded negative results. During my collecting expedition to Mt. Penrissen I naturally had no tame animals with me, and therefore was unable to experiment with *Chlorophorus annularis*, whilst in Kuching the species of *Demonax* and *Clytanthus*, though common enough, are never obtainable in large enough quantities at one time, a very necessary consideration when one experiments with that most inquisitive of animals, the common Macaque (*Macacus cynomolgus*),

which will devour a single specimen of beetle or butterfly entirely for the sake of curiosity, only manifesting disgust or the reverse when that curiosity is fully satisfied.

Of the mimicking species it is not necessary to say much, their resemblances to their models being in every case most obvious.

Amongst the Lamiidæ, the *Phytocinæ* again yield the majority of mimetic species (a newly-discovered *Daphisia*, yellow in colour, is banded with black in almost identically the same manner as *C. annularis*) (compare figs. 34 & 31 on Plate XX.); and amongst the Cerambycidæ, the *Lepturinae* are also fruitful in this respect. One species of *Leptura*, with reddish head and prothorax and yellow black-banded elytra, is closely similar to *Demonax mustela* (compare figs. 40 & 39, Plate XX.): another species allied to *Leptura histrionica* (Pasc.), black with cream-coloured bands, is not readily distinguishable from *Xylotrechus decoratus* (compare figs. 42 & 41) and one or two species of *Demonax*. Plate XX. and its explanation should be consulted for the representation of other examples given in Table III. but not further indicated in the text. *Polyphida clytoides* (Pasc.), *Psalanta chalybeata* (Pasc.), and *Chlorisanis viridis* (Pasc.) I have never seen, but good figures of them are published in Pascoe's paper on the Longicornia Malayana (Trans. Ent. Soc. ser. 3, vol. iii.). The remaining mimics of the iridescent green *Callichrominae*, viz. Nos. (4), (10), and (12) in Table III., are shown in figs. 47, 48, and 44 on Plate XX. and their models in figs. 45, 46, and 43.

[The mimetic resemblance to the *Clytinae* exhibited by so many species of distantly related Bornean Longicorns is of extreme interest. The widespread species of this dominant group have developed, in a great majority of cases, a black and yellow or black and orange transverse banding, which superficially resembles the characteristic appearance of wasps and hornets. This rough resemblance is further heightened by the active movements of the living beetle, which suggest those of a Hymenopterous rather than a Coleopterous insect. Such an appearance is found in *Clytinae* of many species from the whole Palæarctic and Nearctic belt, from Mexico, Malaya, Australia, and probably many other countries. An Australian species, *Arideus thoracicus* (Donovan), has the deep brownish-orange colour of the alternate stripes, as well as the comparatively few broad black bands which are characteristic of wasps from the same region. *Clytanthus sex-guttatus* (Lucas) from Morocco suggests the appearance of a Mutillid or perhaps a Clerid with a Mutillid form of colouring. The Bornean *Scoethrus amœnus* (Gory) mimics the aggressive Coleopterous *Tricondyla* (Cicindelidæ), while species of the *Tillomorphinae*, allied to the *Clytinae*, mimic ants, e. g., *Euderces picipes* (Fab.) of N. America and *Clytellus westwoodi* (Pasc.) of Borneo. Thus we witness within the limits of one large group of Coleoptera a great development of mimicry of aggressive specially protected forms. Such mimicry has been hitherto assumed to be Batesian (pseudaposematic), although the dominance

of the group in which it is manifest, the abundance and wide range of individuals in the species as well as of the species themselves, together with the remarkable predominance of mimetic resemblances among them—all tended to create a strong suspicion that the mimicry is Müllerian (synaposematic). This suspicion is now justified. The discovery of many Bornean Longicorn mimics of *Clytinae* renders it in every way probable that the group is specially defended by some unpalatable quality, and sometimes develops warning colours of its own which are deceptively resembled by other beetles, although it usually makes use of warning colours which are common to more aggressive and even more highly-protected insects. Thus the conclusions which were found to hold in the case of the Cleridæ (p. 248) also apply, with equal probability, to the *Clytinae*. Since the above was written Mr. Gahan has shown me a beautiful example of Batesian or Müllerian mimicry within the group of *Clytinae*, the common *Demonax walkeri* (Pasc.) being resembled in the closest manner by the rarer *Perissus myops* (Chev.). Both beetles had come to the British Museum in a single consignment from Ceylon. There is similarly a very remarkable resemblance, probably Müllerian, between *Xylotrechus pedestris* and *Demonax viverra* (compare figs. 29 & 35 on Plate XX.).—E. B. P.]

COLEOPTERA OTHER THAN LONGICORNS AS MIMICS.

Mimic. *Tillicera* sp., near *biballeata* (Gorh.) (Fam. Cleridæ).
Plate XXIII. fig. 49.

Model. *Mutilla* sp. near *urania* (Sm.). Plate XXIII. fig. 48.

The *Mutilla* has a red head and thorax and black abdomen, the second abdominal segment bears a white spot, the third segment is covered with a creamy white pubescence. In the beetle, the eyes and front of head are black, the vertex of the head and the prothorax are red; the elytra are black with one white band replacing the white spot and another sub-apical band paralleling the white abdominal segment of the *Mutilla*. Curiously enough, the male of this species of *Mutilla* bears a white band in place of a white spot, and hence the beetle more closely approaches the male than the female in its markings: still there is no question as to which sex serves as the model in this case.

Several specimens of the same species of *Tillicera* and of a closely-allied one are in the Hope Collection, Oxford, all collected by Dr. A. R. Wallace in Sarawak.

IV. LEPIDOPTERA AS MIMICS.

So much has been written, by abler pens than mine, on mimicry amongst the Eastern Lepidoptera *inter se*, that I have confined myself to drawing up merely a table of such mimetic species as occur in Borneo, with the addition of a few notes on the bionomics of certain species. Three remarkable examples of lepidopterous

mimics which came under my observation—namely, a sphingid larva mimicking a snake, a noctuid larva mimicking an ant, a moth mimicking a plant-bug—deserve, however, further notice and are here described at length.

i. **Mimic.** Larva of *Cherocampa mydon* (Walk.).

Model. A Snake, e. g. *Dendrophis picta* (Gm.).

I must confess that I have always hitherto regarded as somewhat fanciful those recorded cases of lepidopterous larvæ mimicking snakes and other vertebrate animals, though experiments have shown that the resemblances, even when imperfect, serve to rouse respectful curiosity, if not actual terror, in prospective enemies. I was therefore singularly delighted to secure a larva whose resemblance to a snake was so startlingly accurate that I was for a moment completely deceived.

The general colour was a dark olive-brown, becoming lighter anteriorly: the head, the first and second and the dorsal surface of the third and fourth segments were pinkish; at the junction of the third and fourth segments on each side was an ocellus, not a huge black disc, out of all proportion to the mimicked head, as in all the recorded similar examples, but of very nearly the exact size of the eye in such a snake as *Dendrophis picta*: the lower border of this was margined with bright gold (the colour of the iris in many snakes), giving an upward look and a most malevolent cast to the countenance; the black of the ocellus was so intense and glossy that an idea of depth was given, and it was difficult to believe that one was not looking through a cornea into a pupil. Running through the ocellus on each side was a broad black stripe exactly as in *Dendrophis picta*, while a wrinkled fold on each side of the lower half of the second, third, and fourth segments gave an admirable impression of the division between the upper and lower jaws of a snake. Not the least remarkable of these extraordinary devices was the flatness of the area bounded by the two "eye-stripes" on the dorsal surface of the third and fourth segments; this area together with the first and second segments were pink, reticulated with fine brown lines and strokes, giving an impression of the scutes on a snake's head; they were particularly well-marked on the first and second segments, being there more distant and distinct, and looking extremely like the divisions between internasal and præfrontal shields.

When the larva was moving about with the anterior segments well expanded, the resemblance to a snake was not so startling, but directly it was touched the terrifying attitude was assumed, the anterior segments being drawn in and the front of the body turned towards the aggressor; when, at the same time, the posterior part of the body was hidden by leaves the deception became complete, and if effective enough to deceive, even temporarily, a human being, it must surely be equally effective in deterring less highly organized and more timid foes.

Unfortunately I was unable to test the efficacy of the disguise for fear of losing the larva, which I was anxious to rear for the purpose of identification.

ii. **Mimic.** *Larva of a Noctuid Moth* (? Genus *Tinolius*).

Model. An Ant, *Ecophylla smaragdina* (Fab.).

In Jan. 1900 a curious Noctuid larva of the subfamily *Quadri-fince* was pointed out to me by Mr. H. N. Ridley in the Botanic Gardens, Singapore, resting on a leaf of a tree much frequented by the common red ant *Ecophylla smaragdina*.

Nearly all the segments of the body are furnished with fragile tentacle-like processes which are capable of quivering movements, and so loosely attached that very careful handling was necessary to secure a perfect specimen.

The arrangement of these tentacles is as follows:—

- Segment 1. 3 pairs: 1 pair lateral, 2 pairs dorsal pointing forwards.
- „ 2. 3 pairs: 1 pair lateral, 1 pair sub-lateral, 1 pair dorsal.
- „ 3. 2 pairs lateral.
- „ 4. Unprovided with tentacles.
- „ 5-10. Each with 1 lateral pair.
- „ 11. 2 lateral pairs.
- „ 12. 1 lateral pair.
- „ 13. 2 lateral pairs, the most anterior being very delicate, the most posterior strong and curved backwards.

Segment 8 is dorsally produced into a sharp-edged prominence. The anal prolegs are somewhat disproportionately large and can be widely divaricated; just above each is a prominent black spot: the colour of the body is brown of the exact shade of the *Ecophylla*, with a narrow yellow line on each side. When the larva is irritated, the posterior part of the body is immediately reared in the air, the anal prolegs are thrown widely apart and the tentacles, especially the most posterior pair, are violently agitated. When the caterpillar is seen in an end-on position or when the anterior two-thirds of the body are hidden, the resemblance to the ant is positively startling: the black eye-spots represent the eyes, the widely-diverging anal prolegs, the gaping jaws and the tentacles, the antennæ and legs of the model; the posterior pair of tentacles are so curved that they represent very accurately the elbowed antennæ of the ant.

It might be thought essential, in cases of mimetic lepidopterous larvæ such as the two examples just described, that the greater part of the body should be concealed in order perfectly to deceive prospective enemies: for example, in the sphinx-moth larva it is only the head of the snake that is copied, but is it necessary for the larva, in order to obtain immunity, that it should conceal its disproportionate shortness of body, thus arguing for it a degree

of appreciation of its shortcomings with which such lowly organisms are not usually credited? It seems to me more reasonable to compare such mimetic examples to the pictures of a painter, who strives not to make an exact copy of a scene or object, but to give an essential idea or impression of it, unintelligible perhaps to many, but full of significance to those for whom a picture is more than a mere photograph in colours.

[It is not necessary to adopt the improbable view that the caterpillar has any "appreciation" of the situation, even if we may reasonably believe that the mimetic resemblance is aided by partial concealment. A larva living among leaves is apt to be partially concealed by them and to be protected by the concealment. The appropriate attitude would arise through natural selection without the intervention of intelligence on the part of the larva.—E. B. P.]

The *Ecophylla*, one would imagine, has firmly established a reputation for ferocity, and consequently the mimicking Geometer larva can the more easily deceive its enemies, in spite of its too elongate body. Only two specimens were found, both were walking on leaves and were readily distinguishable; but the violently threatening attitude each assumed when irritated was unmistakable, and the resemblance of the elevated posterior end to the ant so striking, that it is difficult to imagine how a lizard or frog with a previous experience of the ant could fail to be deterred.

I shall have later to draw attention to a Spider which mimics the same ant, but this is a case with a different significance, viz., that the mimic may be enabled to prey undisturbed on its model.

It is a curious coincidence that, in both the larva and the spider, it is the posterior end that mimics the head of the ant—a coincidence which possibly has its meaning.

iii. **Mimic.** *Pharuda limbata* (WlIngrn.). Plate XXIII. fig. 3.

Model. *Serinetha abdominalis* (Fab.). Plate XXIII. fig. 2.

The head, thorax, and coriaceous part of the elytra are, in this Hemipteron, of a bright vermilion-red, whilst the membranous part of the elytra, the legs, and antennæ are black. The moth has the head, thorax, costal margin, and basal half of the fore wings also vermilion, with the remaining portion black, the hind wings are coloured in the same way. I had long been familiar with the moth from cabinet specimens, but until I went to Singapore and saw the insect alive I had not suspected the significance of this very striking coloration. When the moth is in a state of repose, resting, for example, on a plant-stem, the wings are laid back and overlap in the characteristic moth-like manner, and in this attitude the resemblance to the bug is very striking (compare figs. 3 & 2, Plate XXIII.). The hind wings, although entirely hidden, nevertheless serve the purpose of giving an impression of complete opacity to the fore wings, the red and black areas of which in this attitude overlap the similar areas of

TABLE IV.—*The Pseudoposematic and Synposematic Species of Bornean Lepidoptera.*

Models.	Mimics.				
	Subfam. <i>Nymphalinee</i> [? pseudoposematic].	Subfam. <i>Elymninee</i> [pseudoposematic].	Subfam. <i>Papilioninee</i> [chiefly pseudoposematic].	Subfam. <i>Pierinee</i> [synposematic].	Subfam. <i>Chatoosinee</i> [synposematic].
Subfam. <i>Danaeae</i> .					
<i>Ideopsis daos</i> .....	.....	.....	<i>Papilio delesserti</i> ♀ .....	.....	{ <i>Isbarta pieridoidea</i> (Herr-Schäff).
<i>Radana vulgaris</i>	<i>Euripus halitherses</i> ♂	<i>Elymnias lais</i> ♂	<i>Papilio megarus</i> .		
<i>Radana juvena</i> .....	.....	.....	<i>Papilio delesserti</i> ♂.		
<i>Limnas chrysiippus</i>	<i>Hypolimnas misippus</i> ♀.	.....	<i>Pap. macareus macaristus</i> .		
<i>Tirumala septentrionis</i>.	.....	.....	.....	<i>Nepheronia lutescens</i> ♀.	
<i>Bahora aspasia</i> .....	.....	.....	
<i>Cadaga larissa</i> .....	.....	<i>Elymnias lais</i> ♂.			
<i>Parantica erys</i> .....	.....	<i>Elymnias arua</i> , n. sp.	{ <i>P. paradorus telesicles</i> ♀, var. <i>russus</i> , <i>P. paradorus telesicles</i> ♀, var. <i>leucothoites</i> , <i>P. leucothoe ramacens</i> .		<i>Isbarta macularia</i> ♀.
<i>Tronga crameri</i>	<i>Hypolimnas anomala</i> ♂.	.....	<i>Pap. slateri lewitsoni</i> .		<i>Amesia hyala</i> ,
<i>Adigama scudderi</i> .....	.....	.....	.....		{ <i>Mimnplaea tristis</i> (Jordan).
<i>Penoa zonata</i> .....	.....	<i>Elymnias lutescens</i>	<i>Pap. paradorus telesicles</i> ♂.		{ <i>Pompeon subcyanea</i> , <i>Callamesia striata</i> ♂.
<i>Penoa menetriesii</i>	{ <i>Euripus latitherses</i> ♀, var. <i>cinnamomus</i> , <i>Hypolimnas anomala</i> ♀ }	<i>Elymnias lais</i> ♀	<i>Pap. paradorus telesicles</i> ♀.		<i>Callamesia striata</i> ♀.
<i>Trepischrois mulcheri</i> ♂	.....			
" "				
" "				

<i>Danisepa lowei</i> ♂			<i>Papilio canuus mendax</i> ♂.			} <i>Mimaphysa rhadama-</i> } <i>manthus</i> .
" " ♀			<i>Papilio canuus mendax</i> ♀.			
<i>Isamia aegyptus</i>	same models as those	of <i>E. erameri</i> .				<i>Isbarta pandemia</i> .
Subfam. <i>Pierinae</i> .						<i>Isbarta dissimulata</i> .
<i>Delias pandemia</i>		<i>Elymnias golfeyi</i>				} <i>Callamesia pierid-</i> } <i>oides</i> (Walk).
<i>Delias aglata</i>						
<i>Delias cathara</i>						<i>Prionocris cornelia</i> .
<i>Delias singhapura</i>						
<i>Terias sari</i>	}					<i>Isbarta inclusus</i> .
<i>T. nicobaricus</i> .						
Subfam. <i>Papilioninae</i> .						
<i>Papilio aristolochia</i>	}		<i>Papilio polytes thesens</i> ♀.			
<i>antiphus</i>			<i>P. memnon</i> ♀, var. <i>erebinus</i> .			
<i>Papilio erebus</i>			<i>Papilio memnon</i> .			
<i>Papilio noctis</i>						<i>Eterusia obliquaria</i> .
Fam. AGARISTIDÆ.						
<i>Scrobigeria hesperitoides</i>		<i>Cethosia hypsea</i>				
Fam. GEOMETRIDÆ.						
<i>Euschema subrepleta</i>						<i>Camercos gloriosus</i> .

the hind wings. Both mimic and model were taken in daytime in the Botanic Gardens, Singapore, and both were equally conspicuous; subsequently both species were found in Sarawak¹.

The following species are discussed below:—

	Mimics.	Models.
Subfam.	<i>Symbrenthia hippoclus</i> with the mountain forms. <i>S. hypatia</i> var. <i>hippocrene</i> and <i>S. hypselis</i> var. <i>balunda</i> . <i>Athyma</i> spp.	Yellow-and-black <i>Neptis</i> . e. g. <i>N. hordonia</i> , <i>N. tiga</i> &c. White-and-black <i>Neptis</i> . <i>Eoxylides tharis</i> . <i>Drupadia boisduvalii</i> var. <i>atra</i> . <i>Biduanda thesmia</i> .
<i>Nymphalinae</i> .		
Fam.		
LYCÆNIDÆ.	<i>Thirix goma</i> <i>Poritia plateni</i> <i>Araotes lapithis</i>	

NOTES ON TABLE IV.

The females of *Euripus halitherses* (D. & H.) are extremely variable, in fact no two specimens of the fine series of this species in the Sarawak Museum collection are exactly alike, and almost every specimen deserves a varietal name of its own, as has been done to a certain extent for the mimetic *Papilio paradoxus telesicles* (Feld.) by Rothschild & Jordan (Nov. Zool. vol. ii.).

It is possible, however, to distinguish three main groups. One, almost entirely dark blue, is a mimic of *Trepsichrois mulciber* (Cr.), and approximates to *E. cinnamomeus* (Wood-Mason). Another is dark brown with a blue gloss and an oblique discal white fascia on the fore wings and some white streaks on the hind wings, and is a close mimic of *Danisepa lowei* (Butl.) ♂; this group is nearest to *E. pfeifferæ* (Feld.). The third group, near *E. euploeoides* (Feld.), corresponds closely in coloration and markings with *Danisepa lowei* ♀. A considerable number of variations of this highly variable species have been separated into distinct species, but I prefer to regard these as merely varietal names.

The females of *Danisepa rhadamanthus* (Fab.) (the continental form of *Danisepa lowei*) have much more white on the upper side and are readily distinguishable from the Bornean representatives, though the males are practically indistinguishable. In accordance with this, the continental forms of *Euripus halitherses* ♀ of the *euploeoides* type have larger white markings on the upper side than the insular forms; I have not seen continental forms of *Isbarta rhadamanthus* (Fab.) or of *Papilio caunus* (Westw.), but I expect that a parallel variation will be found in these. It is curious that the almost identical males of *D. rhadamanthus* and *D. lowei* are extremely common in their respective localities, whilst, on the other hand, the female of *D. lowei* is very rare, and the very different female of *D. rhadamanthus* is as common as its male.

Hypolimnas anomala (Wall.) is very Euploeine in its flight as well as in appearance; it is not an uncommon species and the

¹ [A closely similar example of Müllerian mimicry was sent for exhibition to the Entomological Society in 1894 by Mr. G. A. J. Rothney (see Proc. Ent. Soc. Lond. 1894, p. xv). The species *Phaуда flammans* (Walk.) and *Serinetha augur* (Fab.) were observed in abundance on roots and trunks of trees in Mysore in Nov. 1893 by Mr. Rothney.—E. B. P.]

resemblance is possibly synposematic. There are, at any rate, some good grounds for supposing that *H. nisippus* (L.) is a Müllerian mimic of *Limnas chrysippus* (L.). (See Poulton: "Mimicry in Butterflies of the Genus *Hypolimnas*," Proc. Am. Assoc. Adv. Sci. 1897, vol. xlv. p. 242.)

Elymnias nigrescens (Butl.) and allied species are in India and elsewhere mimics of *Euploeinae*; no *Euploeinae* serving as models to *E. nigrescens* occur in Borneo, though the species is common enough. The subfamily *Elymniinae* is an interesting one, as affording examples of species endowed with a double means of protection against the attacks of their enemies. The majority of the Bornean species are on the upper side good mimics of *Euploeine* or *Pierine* models, whilst on the under side they are mottled with grey and brown, so that when at rest they are indistinguishable from their surroundings.

Elymnias lais (Cr.) occurred on Mt. Penrissen, and I had ample opportunities of observing something of its habits. The male is black above with green streaks, a common type of coloration amongst the *Danainae* (e. g., *Radena vulgaris* (Butl.), *Caduga larissa* (Feld.), *Parantica eryx* (Fab.), &c., &c.), whilst the under side is mottled. The female is a mimic of *Trepsichrois mulciber* (Cr.) ♀, but I have never seen this sex alive. The green-and-black *Danaines* *Caduga larissa* (Feld.) and *Parantica crowleyi* (Jenner Weir) were abundant on Mt. Penrissen, so much so, indeed, that after two days' collecting they were left in peace. Their flight was leisurely and flaunting, so that they were always readily distinguishable. Their mimic, the *Elymnias*, flew more rapidly, but even then attracted one's attention as being remarkably similar to its models. By the time one had realized the true nature of the insect, it had flown past and a critical moment was gone. If the butterfly was followed up, it would be seen to settle on some twig or stalk with the wings closed, but on coming up to close quarters one might search for it in vain; any sudden movement would cause it to dart away, displaying once again its *Danaine* coloration, to some other resting-place, and so the hunt would be continued *ad nauseam*.

Elymnias godferyi (Dist.) mimics *Delias aglaia* (Linn.), and has on the under side some appropriate yellow and red markings, which are, however, somewhat obscured by mottlings of brown. We have here, in fact, a species which is beginning to discard a uniform mottled under side in favour of brighter mimetic coloration, such as is seen in some species from New Guinea and the neighbouring islands, which mimic very closely on both surfaces of the wings *Euploeine* and *Pierine* butterflies, and have discarded entirely a protective coloration.

Elymnias aroa, sp. n., is described in Appendix I. to this paper: only two specimens were captured. It is a fairly good mimic of *Tronga crameri* (Lucas), which occurred with it.

The common day-flying moths the *Agaristid* *Scrobigeres hesperioides* (Wlk.) and the *Chalcosid* *Eterusia obliquiaria* (Wlk.) are

closely similar in wing pattern and colour (compare figs. 7 & 8, Plate XXI.); their coloration recalls that of *Heliconius clysonymus* (Latr.) and *H. ricini* (L.) of S. America and of the common Oriental *Cethosia hypsea*.

[The majority of the Chalcosid synaposemes named in Table IV. are shown on Plate XXI. together with their Euplœine, Pierine, and Agaristid models. The resemblance to the *Pierine* is so much more striking and the patterns so much more detailed and varied on the under sides of the wings, that this aspect is alone represented in the case of both Pierine models and their Müllerian mimics (figs. 1 to 6, Plate XXI.). *Delias cathara* (Grose-Smith) is very rare, whilst its mimic *Callamesia pieridoides* (Wlk.) (compare figs. 5 & 6) is comparatively common, a fact which supports the Müllerian interpretation. A comparison of the whole series of Chalcosid mimics and their models leaves no doubt that the moth is the mimic and the butterfly the model, even though the former be common and the latter rare.—E. B. P.]

The species of *Symbrenthia* and of *Athyma* have a close resemblance to the Neptides, all of which are highly distasteful. The association in this case is probably Müllerian.

The extremely common Lycaenidæ *Eoxylydes tharis*, *Drupadia boisduvalii*, and *Biduanda thesmia* are mimicked by *Thrix gama*, by *Araotes lapithis*, and by *Poritia plateni*. In this case the mimicry is Batesian. Mr. de Nicéville, in his 'Butterflies of India,' vol. iii. p. 11, gives a list of mimetic Lycaenidæ compiled by Doherty, but he informs me that Doherty conducted no experiments to prove the correctness of his association of the various species in mimetic examples. I am, however, quite certain that *E. tharis*, *D. boisduvalii*, and *B. thesmia* are distasteful species, whilst the great rarity of the mimicking species points to the conclusion that they are Batesian mimics.

V. DIPTERA AS MIMICS.

A complete list of the mimetic flies of Borneo would comprise at least one-third of the total number of species, but inasmuch as the literature on the Malayan Diptera and their Hymenopterous models is both scanty and scattered, I think it advisable to postpone the compilation and discussion of such a list until our knowledge of these two orders as represented in the East is increased and more systematized. I therefore select for special notice and description eight species only, each of which exhibits some noteworthy modifications of structure and habit, produced in the attainment of a likeness to its respective mimic.

i. **Mimic.** *Laphria* sp. near *terminalis* (v. d. Wulp). Plate XXII. fig. 10.

Model. *Salix sericosoma* (Smith). Plate XXII. fig. 9.

This large and handsome fly is not infrequently met with in the neighbourhood of Kuching, and the immunity which it

enjoys is doubtless due to the closeness of its resemblance to an equally conspicuous *Salix*, an ally of which has already been noted as the model of a Longicorn beetle. The fore wing of the *Laphria* is large, almost as broad as both fore and hind wing together of the *Salix* and of the same clear golden-brown. The thorax, as in the wasp, is covered dorsally with a golden pubescence, whilst the abdomen, like that of the model, is black, and terminates in a sharp tufted point very suggestive of a sting. All the tibiæ and tarsi are ochreous, but the black and thickened femora are very unlike those of the *Salix*. No attempt at mimicking the long ochreous antennæ of the wasp is made, as in some other Diptera shortly to be described (compare figs. 9 & 10, Plate XXII.). The buzzing, noisy flight of this fly is very like that of its model.

[In the natural attitude of rest it is probable that the black femora of the fly are held upright and near to the body, so that the ochreous parts of the legs would alone be conspicuous. It is noteworthy that the *under sides* of the anterior femora are ochreous, suggesting that the anterior limbs may in certain attitudes be raised, or, at any rate, that they are held so that this part is more conspicuous than any other femoral surface. It is probable that this special colouring is directed to meet a view from the front. It is to be hoped that future observations will be specially directed to these points. This fly belongs to the family of the Asilidæ (subfamily *Laphrineæ*), the most formidable and predaceous of Diptera, and it is quite possible that the resemblance to a wasp is Müllerian (synaposematic) rather than Batesian (pseudaposematic).—E. B. P.]

ii. **Mimic.** *Hyperechia fera* (v. d. Wulp). Plate XXII. fig. 2.

Model. *Xylocopa latipes* (Drury). Plate XXII. fig. 1.

No more remarkable proof of the plasticity of the Dipterous form could be advanced than this remarkable insect. The large, clumsy *Xylocopa*, with its bronzy wings and thick furry legs, would seem to be an eminently unsuitable and difficult model to copy; and it would be most instructive, if only it were possible, to trace the steps by which this fly has arrived at what at first sight appears to be the pitch of mimetic perfection. As a matter of fact the fly is extremely rare, and one can only conclude that the mimicry, exact though it seems, has failed to preserve the species as a dominant one.

The head is characteristically Dipterous; the thorax is of shining blue-black, clothed with a fine dense pubescence, coarser and longer on the sides; the broad, flattened abdomen is laterally bordered with a fringe of long hairs exactly as is the case with the *Xylocopa*, and terminates in a fine tufted process suggesting a sting. As in *X. latipes*, all the legs are remarkably hairy and sturdy, particularly the last pair, and are of much the same length. The wings are of a bluish-bronze hue: the downwardly-

curved submedian vein in the wing of the fly represents the junction between the fore and hind wings of the bee, and the areolet of the hind-wing of the bee also finds its parallel in the alula of the fly. The halteres are quite concealed amongst the hairs on the sides of the thorax. I have only seen one solitary specimen of this fly (Kuching, Feb. 1899), and have nothing to record of its habits beyond stating that both on the wing and at rest it was exceedingly difficult to distinguish from the common *X. latipes* (compare figs. 1 & 2, Plate XXII.).

[It is possible that the fly is constantly mistaken for a Xylocopid, and that it is not nearly so rare as it appears to be. The genus is widespread, and Mr. G. A. K. Marshall has sent me an equally beautiful example from Mashonaland. In this case the insect is unique (it has been recently described as *Hyperechia marshalli* (Austen)), but Mr. Marshall's notes clearly indicate the reason of its rarity. It must be remembered also that the extreme perfection of the resemblance is aided by the rapid flight and alertness of the fly. *Hyperechia* belongs to the same family and subfamily as the species last described, and here, too, the Müllerian interpretation must be taken into account. In fact Mr. Roland Trimen, to whom I showed the African specimen, expressed the opinion, from his experience of its allies, that it is a far more formidable insect than its model. The strengthening and curvature of the submedian vein in the fly's wing, which apparently represents the junction between the bee's fore and hind wings, is an instance of the attainment of a detail in the resemblance by a very slight alteration of form; for the vein in the last-described species of fly pursues nearly the same curved direction, although the line of junction of the wings of its model is nearly straight. In both species of fly there is a slight break in the even contour of the margin at the point where this vein reaches it, which is very suggestive of a junction between fore and hind wings, while the curve of the margin is changed on either side of the break in such a manner as further to promote the resemblance.—E. B. P.]

iii. **Mimic.** *Milesia vespoides* (Wlk.). Plate XXII. fig. 14.

Model. *Vespa cincta* (Fab.). Plate XXII. fig. 13.

The large wasp, black with a broad red band on the second abdominal segment, is closely mimicked by an equally large fly with the distal half of the second segment and the proximal half of the third segment coloured red. This red band, though actually occupying a different position from that of the wasp, is separated from the thorax by a black interspace nearly equal in breadth to the wasp's first abdominal segment, which is also black. The wings are similarly coloured in both species (compare figs. 13 & 14, Plate XXII.).

iv. **Mimic.** *Midas*, n. sp. (Fam. Midaidæ.) Plate XXII. fig. 12.

Model. *Macromeris violacea* (Lep.). Plate XXII. fig. 11.

Macromeris violacea, a dark blue fossorial wasp, with dark blue

wings resplendent with metallic blue sheen, occurs commonly on the mountains near Kuching. On Mt. Santubong a fly was recently captured affording a close resemblance to the wasp. The body and legs are exactly of the same shade of colour as are those of the wasp; the wings, though somewhat browner, are more opaque and possess a blue metallic sheen sufficiently deceptive. Their size is large (larger than the fore wing alone of the wasp), and it is interesting to note the same downward curve of the submedian vein as was found in *Hyperechia fera*, suggesting the line of junction between a fore and a hind wing. The antennæ are fairly long, though far shorter than those of the wasp. I have not seen this species in the living state, but even as a cabinet specimen it is a remarkable case of deceptive resemblance (compare figs. 11 & 12, Plate XXII.).

Specimens of this fly from the Philippines and Tenasserim are in the British Museum collection of Diptera.

v. **Mimic.** *Physocephala* sp. (Fam. Conopidæ.)

Model. *Ischnogaster micans* (Sauss.).

This example has been selected at hazard from a large number of similar thin-waisted flies, chiefly Syrphidæ and Conopidæ, as typical of the method by which the similarly built Eumenidæ and Vespidæ are mimicked. The first abdominal segment is much attenuated and drawn out, those following are thickened; the transparent wings are shaded with fuscous on their anterior borders, in accordance with a similar arrangement in the wasp; the head is the only part which exhibits any of the yellow colouring of the model.

vi. **Mimic.** Gen. et sp. ? (Fam. Stratiomyidæ, subfam. *Raphiocerinae*.) Plate XXII. fig. 6.

Model. *Mesostenus* sp. near *pictus* (Smith). Plate XXII. fig. 5.

Both species were taken on Mt. Penrissen on the same day, and the similarity of their external appearance was equalled by the similarity of their method of flight and action when at rest. The Ichneumon-fly was common enough, and was frequently seen to hover over a plant for a few minutes, then suddenly drop down and pitch on to a leaf, over which it would walk, moving its white-banded antennæ up and down with a quick flickering movement. The fly, of which only one specimen was caught, behaved in exactly the same manner; it would hover, then suddenly settle and walk over a leaf on its mid and hind pairs of legs, waving rapidly up and down its long front legs, the tibiæ of which being black and the tarsi white, most closely resembled the antennæ of the Ichneumon-fly. The femora were kept more or less pressed against the ventral surface of the head, so that the sham antennæ seemed actually to arise from the correct position. This method of bringing about a resemblance to long antennæ is

also made use of by several species of *Calobata* and allied genera, but in the case here described the mimicry of an Ichneumon-fly is carried still further, inasmuch as the coloration is almost identical in both species, viz., black with yellow spots on the head and thorax, with alternate yellow bands on the abdomen, while the legs are ochreous with a black band at the apex of the femora and tibiae. Furthermore, the ample clear wings are very similar in both mimic and model (compare figs. 5 & 6, Plate XXII.). The nearest allies of this remarkable fly occur in S. America.

vii. **Mimic.** ? *Xylophagus* sp. (Fam. Leptidæ.) Plate XXII. fig. 8.

Model. *Mesostenus* sp. Plate XXII. fig. 7.

This example is remarkable for the great elongation of the antennæ of the fly. In the previous case it was seen that the long antennæ of the model were represented by the fore legs of the mimic, but here there is an actual copy produced by means of a very unusual modification amongst the Diptera. The mimicry is so perfect that it will almost bear a close scrutiny through a lens; the large eyes, prominent clypeus, and maxillary palps of the fly give the head, even when thus closely examined, a characteristic Hymenopterous appearance. For the rest, the coloration is almost identical in both species: black with yellow spots and bands (compare figs. 7 & 8, Plate XXII.). The larva of the fly was found in decayed wood and presented no very extraordinary features.

viii. **Mimic.** *Sepedon* sp. near *javanicus* (Desv.). (Fam. Sciomyzidæ.) Plate XXII. fig. 4.

Model. *Collyris emarginata* (Macl.). Plate XXII. fig. 3.

It is not usual to find amongst the Diptera species which mimic any other order of insects than the Hymenoptera. This example and a species of *Celyphus*, which only very doubtfully can be considered as mimicking a small bug, are the only cases known to me.

Both of the species now under discussion were caught together on the wing on Mt. Serambu, Sarawak, and when seen alive and actively moving about were not readily distinguishable. As cabinet specimens they furnish an instance of the importance of field-work in the study of mimicry, and of the unreliability of dead impaled insects or mere figures unless, indeed, both are prepared with reference to careful observations of the living forms. The fly when alive was of a very brilliant blue like that of the *Collyris*, but the colour has now faded to a dusky indigo, while the abdomen being much shrunk detracts considerably from the previous resemblance. The legs are brilliant red, and constituted one of the most conspicuous features of both fly and beetle (compare figs. 3 & 4, Plate XXII.).

VI. RHYNCHOTA AS MIMICS.

α. Rhynchota Hemiptera.

i. **Mimic.** A *Reduviid*, sp.

Model. *Bracon*, sp.

The bug has the elytra, wings, and dorsal surface of the body reddish ochraceous as in certain common Braconidæ; the abdomen beneath is white; the apex of the coriaceous part of the elytra is black, thus resembling the black stigma on the fore wing of the model; while both elytra and wings are suffused with fuscous as in the model. So perfect is the resemblance between the two species that the bug was placed in a cabinet together with several other Hymenoptera, and the mistake was only discovered quite recently whilst attempting to arrange the museum collection of Braconidæ.

Another species, probably of the same genus of bug, mimics another similarly coloured species of *Bracon* in the same manner as above described.

[See also under section *Convergent Groups* for other examples of mimetic Hemiptera.]

β. Rhynchota Homoptera.

ii. **Mimic.** *Issus bruchoides* (Wlk.). Plate XIX. fig. 10.

Model. *Alcides*, sp. (Cureulionidæ.) Plate XIX. fig. 9.

This remarkable little Homopteron, one example only of which is in the British Museum from Sumatra, occurs not uncommonly at Kuching on fallen logs or on living wood, whilst the Weevil is frequently found beneath the bark of fallen logs, sometimes in the very logs on the surface of which is found the mimic.

The whole appearance of the mimic with its hard convex elytra and deceptively powerful legs is very weevil-like, and the resemblance was evidently noted by the describer. The fore legs are much flattened and in side-view correspond closely in appearance to the powerful fore legs of the *Alcides* (compare figs. 9 & 10, Plate XIX.).

VII. SPIDERS¹ AS MIMICS.

i. **Mimic.** *Cyrtarachne conica* (O. Pickard-Cambridge).

Model. *A mollusc*.

The abdomen of this Spider is many times larger than the cephalothorax and is dorsally produced into a cone, which appears as if tilted backwards. The colour of the abdomen is creamy or yellowish white, marked with fine black and greenish lines and mottlings, arranged in a somewhat concentric manner so as to

¹ The Spiders here noted were described in P. Z. S. 1901, i. p. 11 *et seq.* pl. v. *Cyrtarachne conica* was wrongly recorded as occurring in Singapore.

represent very closely the whorls of a spirally coiled snail-shell, such as *Helix*.

The spider occurs in Kuching, and is generally found resting on leaves, sometimes with the cephalothorax turned right under the abdomen, in which position it is readily mistaken for a snail-shell, or with the cephalothorax in the normal position. In the latter case, if disturbed, this part of the body is immediately doubled under the abdomen and the animal usually rolls off the leaf, especially if a small one, and becomes lost in the decaying vegetation carpeting the ground below. I have been unable to discover any web, nor have I seen the manner in which the animal hunts or seizes its prey, but it seems probable that this is an example of one of those doubly significant devices whereby an animal is enabled not only to avoid its foes (in this case predatory wasps) but also to approach its own prey unobserved.

[It is possible that this resemblance is cryptic rather than mimetic. The former interpretation seems to be valid in the case of the British larva *Aspilates gilvaria*, which also resembles a snail-shell.—E. B. P.]

ii. **Mimic.** *Amycia lineatipes* (Pickard-Cambridge).

Model. *Ecophylla smaragdina* (Fab.).

I am indebted to Mr. H. N. Ridley for leave to incorporate in this paper the observations which he has made on this mimetic species, which as yet I have failed to find in Borneo. The ant under notice is an extremely common and ferocious species, chiefly remarkable for its nest-building habits. Mr. Ridley has described these habits in the Journal of the Asiatic Society, Straits Branch, 1890, No. 22, p. 345. The spider is of the same colour as the ant (reddish brown), and bears on the posterior part of the rather acutely pointed abdomen a pair of black eye-like spots, so that it is the abdomen of the spider which corresponds to the head, the cephalothorax to the abdomen of the ant. Both mimic and model are found together near the nest of the latter, and so close is the resemblance between the two that the spider is able to prey with impunity on the ants: I have taken a specimen of a spider with the body of an ant sucked nearly dry in its jaws; and Mr. Ridley has seen an individual pounce on an ant and then dropping from its foot-hold on a leaf, hang suspended by a silk thread in order to complete its meal in safety. No web is spun by the spider, but a round disc of silk, probably the egg-cocoon of this species, was found on the under surface of a leaf much frequented by the spider and its models.

iii. **Mimic.** *Salticus attenuatus* (Pickard-Cambridge).

Model. *An Ant*.

Mr. Ridley also sent me from Singapore a remarkable little Attid with a well-marked constriction about the middle of the

cephalothorax and a slender abdominal peduncle, so that the triple division of the insect-body is well imitated. The abdominal peduncle appears to bear a small scale and the abdomen is elongated; the elbowed antennæ of an ant are mimicked by the anterior pair of legs of the spider. I have not been informed whether this species, like the preceding, lives in company with its models.

VIII. CONVERGENT GROUPS.

There are certain combinations of colours in distasteful or otherwise specially protected insects which may be considered as warning: such are, black with yellow bands, black with one broad red band, black with white tips to the wings, yellow or red with black spots, red elytra or wings more or less broadly tipped with black; and we find insects, belonging to the most diverse orders, with one or other of these combinations of colours converging to a central form, a typical distasteful insect. Some of these converging forms may be non-immune and pseudoposematic (examples of Batesian mimicry); others may be distasteful themselves and synaposematic (examples of Müllerian mimicry). For example, all the Lycidæ are strongly distasteful, as I have proved by repeated experiments¹, and large numbers of them show the same type of coloration, the anterior third or two-thirds of the elytra being red, the posterior two-thirds or third black, whilst the head and thorax are black or red. Resembling the members of this group are ten species of Longicorns, belonging to four subfamilies, one Clerid, two Hispids, two Elaters, one Rhipidocerid, one Eucnemid, or seventeen Coleoptera in all, one moth and several Hemiptera. The Lycidæ, then, may be considered as distasteful insects which are characterized by a definite type of warning coloration, whilst the coloration of the insects which resemble them so closely can hardly be looked on as essentially typical of the groups to which the insects belong. The conspicuous Lycid, *Lycostomus gestroi* ♀, is mimicked by three Longicorns—*Erythrus apiculatus* var., *E. rotundicollis* and *sternalis*, and by *Eurycephalus lundii*, by a moth, *Phauda limbata*, by at least four bugs, of which *Ectatops rubiaceus* and *Serinetha abdominalis* alone have been identified.

The arrangement of colours in the Lycid *Metriorrhynchus kirschi*, in the Longicorns *Ephies dilaticornis* and *Erythrus biapicatus*, in the Hispid *Gonophora wallacei* var., and in a Clerid of the genus *Tenerus* (*T. sulcipennis* (Gahan)) is almost identical. *Calochromus dispar* is mimicked by the Longicorns *Pyrestes eximius* and *P. virgata*, by a Rhipidocerid of the genus *Ennomates*, and by an unidentified Eucnemid. The Lycids *Ditonoces* sp. near *fuscicornis* and *Taphes brevicollis*, the Lamiid Longicorn *Xyaste torrida*,

¹ A strong vitality is correlated with this distastefulness; I have seen a Lycid beetle walk away apparently uninjured after it had been well pecked by two or three fowls. The distasteful Endomychidæ are also difficult to kill (cf. also vitality of *Danaïæ*, *Acræinæ*, and *Heliconinæ* noted by various authors).

and the Hispid *Gonophora wallacei* are much alike in their general appearance; and so too are the Lycids *Cautires excellens* and *Metriorrhynchus acutangulus*, the Elaters *Agonischius pectoralis* and *A. (?) sanguineipennis*, the Longicorn *Xyaste fumosa* and *X. invida*, and a Reduviid bug.

The association of these species in one convergent group is represented in a diagrammatic way in Table V. (p. 269): the species other than Lycidæ which I consider to be distasteful are indicated by an asterisk, but it is not improbable that others may hereafter be proved to be Müllerian rather than Batesian mimics.

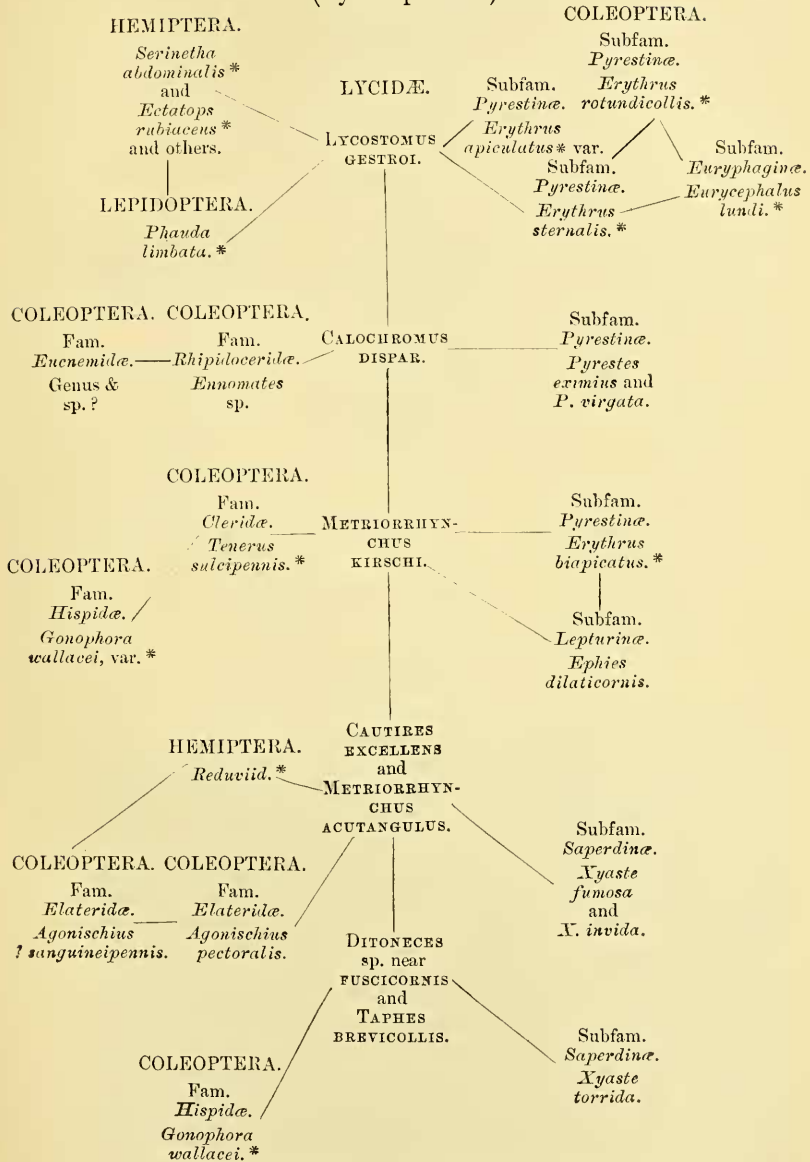
[The prevalent types of Lycid coloration are very simple, being uniform red or ochreous or one of these colours combined with black. The same patterns have an immense range corresponding with the wide distribution of the family over the warmer parts of the world. Hence this beautiful group of Bornean insects of many orders which adopt a colouring characteristic of the Lycidæ could no doubt be paralleled in many countries. Examples of Lycoïd American moths belonging to distasteful groups are given in Journ. Linn. Soc. (Zool.) vol. xxvi. p. 569. Mr. G. A. K. Marshall has sent me a wonderful group belonging to this type, the ground-colour being ochreous, from Salisbury, Rhodesia. The central type is provided by seven species of Lycidæ, and it is resembled by a Telephorid, a Melyrid, two Phytophaga, three Cantharidæ, three Longicornæ, many species of Hymenoptera Aculeata, several Hemiptera, a fly (*Xiphocerus*), a Zygenid moth, and an Arctiid Moth. This group is briefly mentioned in the Report of the British Association (Section D), Bradford Meeting, 1900, p. 793.—E. B. P.]

A second group may be formed out of Coccinellid-like insects. All the well-known Coccinellidæ with red or yellow elytra spotted with black are the central figures of the group, with perhaps an excessively common Cassid, *Prioptera octopunctata*; mimicking these are a Longicorn, *Entelopes glauca* (Pasc.), two species of *Lema* and a *Curculio*, the remarkable new Locustid of a genus near *Gammarotettix*, a Pentatomid bug of the subfam. *Asopinæ*, *Blachia ducalis* (Wlk.), and a spider with large red abdomen spotted with black. The association is indicated diagrammatically in Table VI. (p. 270); the mimics of Coccinellidæ, which are believed to be Müllerian, are indicated by asterisks. Nearly the whole of the species here mentioned are figured on Plate XXIII. figs. 30 to 36. The *Lema* figured (*L. quadripunctata*) is a less perfect mimic than *L. femorata*.

The little Dammar-bee *Melipona vidua* (Lep.), black with white-tipped wings, is an extremely common insect in Borneo, and, though stingless, is protected by its ferocious biting and social habits¹.

¹ A certain tree in the jungle near the Sarawak Museum was known to harbour a nest of this species; when the bees swarmed it was impossible to approach the tree without attracting a large number which settled on one's hair and face and bit so fiercely that a hasty retreat had to be made. A tame monkey, secured by a chain and sliding ring to a bamboo pole which contained a nest of another species of *Melipona*, refused after two attempts to scale the pole when the bees were swarming round the mouth of the nest.

TABLE V.
Convergent Group 1.
(Lycoid pattern.)

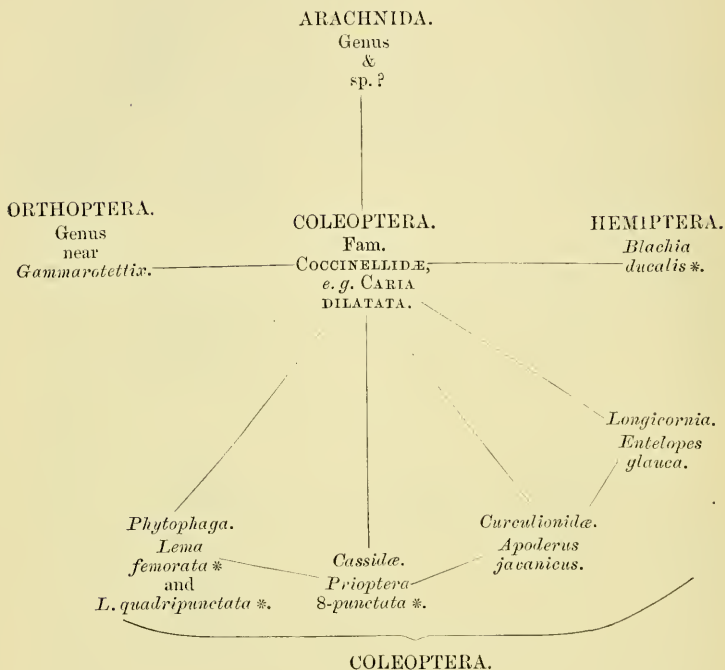


The species mentioned in this table are figured, almost without exception, on Plate XXIII, figs. 1 to 29.

TABLE VI.

Convergent Group 2.

(Coccinellid pattern.)

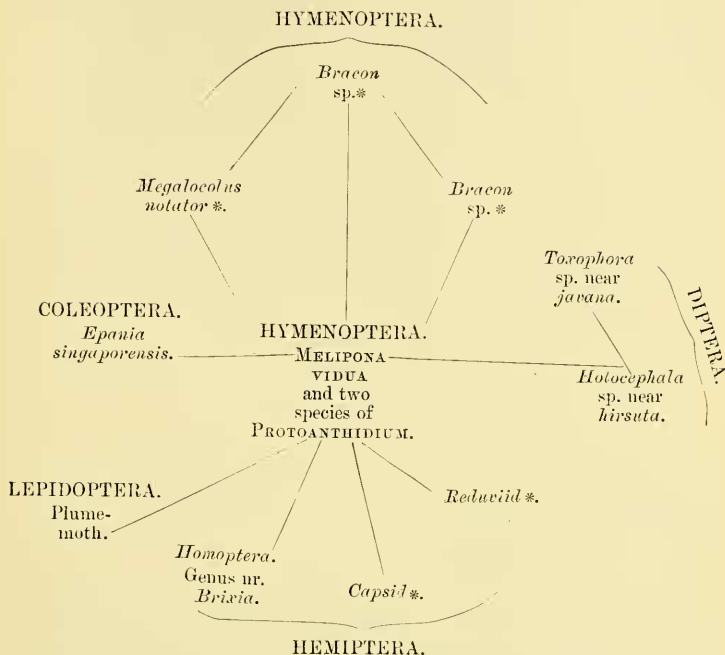


There are two species of *Protoanthidium* coloured in the same way; and there is a large concourse of insects of different orders mimicking this type of coloration, viz.: four Hymenoptera; three species of *Bracon*, one with very hairy hind femora and tibiae simulating the dilated tibiae of its model, and a Chalcid, *Megalocolus notator* (Walk.); a Longicorn, *Epania singaporensis* (Pasc.); a plume moth; a Capsid, a Reduviid, and an obscure Homopterous insect; two flies, *Holocephala* near *hirsuta* (v. d. Wulp), and *Toxophora* near *javana* (Wied.). The resemblances between these mimics and the *Melipona* are in some cases remarkably exact; the Longicorn and the *Holocephala* were taken in the company of the bees; all the mimicking Hymenoptera are indistinguishable from their model whilst on the wing. In this group I consider the *Melipona* to be the central typical warningly coloured and specially protected insect. Asterisks indicate the convergent species which are probably synaposematic in the following diagrammatic arrangement represented in Table VII. (p. 271). The whole of the species are shown in Plate XXIII. figs. 37 to 47.

TABLE VII.

Convergent Group 3.

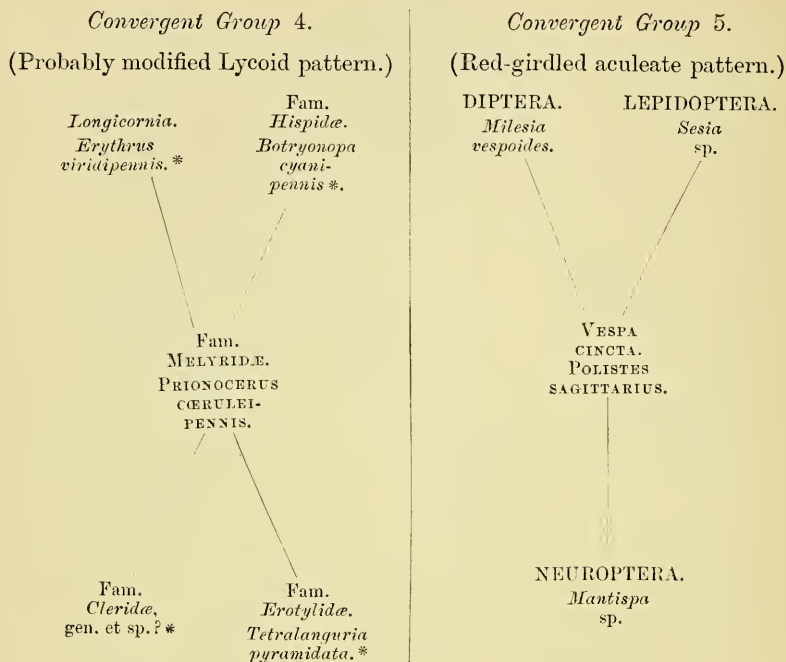
(Melipona-like pattern.)



A fourth group is characterized by the following combination of colours: black head, red thorax, and iridescent green elytra. This type of coloration is well illustrated by a Melyrid, *Prionocerus ceruleipennis* (Perty), a Longicorn, *Erythrus viridipennis* (Gahan), an Erotylid, a Hispid, *Botryonopa cyanipennis* (Baly), and a Clerid. It is probable that the whole of these species are synposematic, as is indicated in the accompanying Table VIII. Group 4 (p. 272). Four of the species are represented on Plate XXIII. figs. 58 to 61.

A fifth group has a broad red band across the middle of the abdomen; into this will fall two common wasps, *Vespa cincta* and *Polistes sagittarius*, and their mimics, a Sesiid moth, a fly, and a Mantispa. There is at present no reason for considering any of the convergent species shown in Table VIII. Group 5 as other than pseudaposematic. The *Mantispa* and *Polistes* are shown in figs. 27 & 26 on Plate XIX., the *Vespa* and *Milesia* on figs. 13 & 14 on Plate XXII.

TABLE VIII.



There is a considerable assemblage of uniformly-coloured ochreous species of Phytophaga of the families Halticidæ, Galerucidæ, etc., and of mimicking Longicorns of the subfamilies *Saperdinae* and *Astatheinae*; these, however, are not included in the table, as sufficient examples have been given clearly to illustrate the wide distribution of a characteristic type of warning coloration.

APPENDIX I.

1. LEPIDOPTERA RHOPALOCERA, by R. SHELFORD.

ELYMNIAS AROA, sp. n.

♂. Dark fuscous brown, with the following cream-white markings:—*Upper side: fore wing*, a submarginal series of spots commencing from below the discoidal nervule, the last one double; some indistinct notching at the external angle; the external margin is somewhat irregularly scalloped: *hind wing*, a sub-discal series of internervular spots and dashes, one of each to each interspace, the last interspace but one carrying a double

set, the last a single streak; a series of large submarginal spots, the last of which fuses with the above-mentioned streak, the others partially or completely distinct; some marginal irregular mottlings. Wing rather deeply scalloped and subcaudate. *Under side* pale fuscous; *fore wing*, costal area black barred with white, some basal white mottlings, submarginal spots more distinct than on the upper side; *hind wing*, some basal white spots, one below the first subcostal nervule, another just below the cell, the subdiscal series very indistinct, the submarginal series of large spots distinct, a marginal mottled band of transverse streaks far more pronounced than on the upper side, inner margin blackish barred with white. Cilia white and fuscous alternately. Expanse 80 mm.

♀. *Upper side* paler fuscous, markings as in the male; *under side* as in the male but the markings more diffuse. Expanse 93 mm.

Hab. Mt. Penrissen, Sarawak.

Types in the Sarawak Museum.

The nearest ally of the species appears to be *E. lutescens* (Butl.).

2. COLEOPTERA LONGICORNIA, by C. J. GAHAN.

ZELOTA, gen. nov. (*Mesosinarum*).

Head deeply concave between the divergent antenniferous tubers; front slightly convex, narrowed between the eyes; gena long and somewhat swollen; eyes divided, rather finely faceted. Antennæ of the male scarcely longer than the body; scape stout, subclavate, furnished at its apex with a short spine behind and a narrow cicatrix in front, the latter completely bounded by a projecting rim; third joint slender, slightly curved, nearly twice as long as the first or fourth, armed at the apex with a sharp spine; 5th to 11th joints very short, together scarcely longer than the 4th; last five or six joints thickly fringed with long hairs underneath, the remaining joints being sparsely ciliate. Prothorax transverse, rounded and unarmed at the sides. Mesonotum without stridulating area, arcuately emarginate in front. Elytra but little longer than their conjoined width, prominent at the shoulders, broadly rounded at the apex; each furnished a little behind the base with a very prominent ridge, surmounted by a tuft of long hairs tapering to a point in imitation of a spine. Prosternum strongly arched, almost vertically sloped behind. Mesosternum short and horizontal behind, subvertical in front. Legs subequal in length; femora fusiform; middle tibiæ without notch on outer margin; claws of tarsi divergent.

This new genus comes near *Cacia* (Pasc.) in the group or subfamily *Mesosinæ*; and in the same section with it should be placed the genera *Planodes* (Newm.) and *Calymmophis* (Thoms.), which Lacordaire, on insufficient grounds, withdrew from the *Mesosinæ*, assigning them a place in his "groupe" *Monohammides*. The genus *Ereis* (Pasc.), which was treated by him in the same way, should also be restored to the *Mesosinæ*, finding a place near the genus *Mesosa*.

ZELOTA SPATHOMELINA, sp. n. (Plate XXIII. fig. 57.)

Nigro-cyanea; capite fere nigro, in fronte subnitido, utrinque pone oculum inferiorem macula rufo-fulvescente notato; prothorace transverso, lateraliter rotundato, antice transversim sulcato, tenuissime griseo-pubescente; elytris sat dense punctulatis, nigro-cyaneis aut violaceis, utrisque maculis duabus aut tribus rufo-fulvis notatis—una communi paullo pone scutellum, secunda ad marginem externam paullo pone basin, tertia fere ad medium disci; pedibus nigro-cyaneis aut violaceis, sparse ciliatis; tibiis extus in medio albo-cinereis.

Long. 7-8; lat. $3\frac{1}{2}$ -4 mm.

Hab. Sarawak. 1 ♂ in Brit. Mus., 2 ♂♂ from Kuching, Sarawak (*R. Shelford*), in the Hope Museum, Oxford.

In the two ♂ specimens in the Hope Museum there is a small spot of reddish pubescence just under the anterior part of the lower lobe of each eye, in addition to the somewhat larger rounded spot of the same kind behind the lobe. In these specimens also the third reddish spot of each elytron—that placed a short distance behind the base of the large tufted tubercle, but a little more externally—is present and distinct, and there is a cinereous patch crossing the elytra a little in front of the apex.

APPENDIX II.

Descriptions of additional Species mentioned and figured in the accompanying paper.

[Received January 5, 1903.]

1. LEPIDOPTERA HETEROCERA, by KARL JORDAN.

MIMEUPLĒA TRISTIS, sp. n. (Plate XXI. fig. 12, ♀.)

♂. Body olive-black, with a rather feeble greenish-blue gloss; under side white-spotted as in *M. rhadamantha*. Wings mummy-brown above and below, not distinctly metallic, except costal margin of fore wing below and a small dot at base of fore wing above. Fore wing, upper side: a series of broad creamy-white streaks from costal margin to SM^2 , separated by the brown veins, the upper ones reaching from margin halfway to cell, the posterior ones shorter and not quite touching margin. A series of streaks also on hind wing, but here thin, submarginal. The streaks present on under side of both wings, broader than above, all reaching margin.

♀. Similar to ♂; streaks of fore wing vestigial and narrow above, the five posterior ones ending proximally in a small white spot, streak M^1-M^2 much longer than the two above and the one below it; streaks of under side of fore wing broader than above, but thinner than in male and much more clayish. No streaks on hind wing above, but vestiges of them present on underside. (Neuration of this specimen abnormal on right fore wing.)

Length of fore wing: ♂ 32, ♀ 36 mm.

Hab. North Borneo: ♂ from Sandakan, June 28, 1894 (D. Cator, in the Tring Museum); ♀ from Kuching, Oct. 1895 (Sarawak Museum, Kuching).

Neuration similar to that of *M. rhadamantha*.

2. COLEOPTERA LONGICORNIA, by C. J. GAHAN.

ERYTHRUS ROTUNDICOLLIS, sp. n. (Plate XXIII. fig. 6, ♂.)

Niger, elytris a basi usque paullo pone medium rufis: antennis quam corpore a quarta parte brevioribus, articulis 5^o ad 10^{um} ad apicem antice dentatis; prothorace lateraliter rotundato, latitudine maximo ad medium, disco tuberculis duobus parvis nigro-pilosis vix ante medium positis instructo; elytris postice rotundatim attenuatis, utrisque ad suturam breviter dentatis.

Long. 17; *lat.* 4 mm.

Hab. Mt. Santubong, 2600 ft., February 4, 1900. One male specimen.

Black, with rather more than the basal half of the elytra red. Antennæ about three-fourths the length of the body, with the joints from the fifth to the tenth produced into a tooth at the antero-distal angle. Prothorax rather strongly rounded at the sides and widest about the middle; the disk with two small velvety tubercles placed barely in front of the middle. Elytra slightly widening from the base up to about the posterior third or fourth, and thence narrowing towards the apex, where each ends in a small sutural spine; the disk of each with a rather feeble costa extending from the base to a little beyond the middle.

This species most resembles *E. atricollis* Pasc., but in the latter the dark apical area of the elytra is less extensive; the prothorax is less rounded, is widest behind the middle, and on the disk has but a single median cariniform tubercle.

ERYTHRUS STERNALIS, sp. n. (Plate XXIII. fig. 7, ♂.)

Niger, elytris a basi usque pone medium rufis: prothoracis disco tuberculo mediano inter medium basinque, et utrinque tuberculo parvo paullo ante basin posito, instructo; elytris postice rotundatim attenuatis, utrisque ad suturam sat valde spinosis; prosterno inter coxas tuberculato, mesosterno postice minus fortiter tuberculato.

Long. 20; *lat.* 4½ mm.

Hab. Mt. Matang, 3600 ft., June 1900. Two male specimens; in British Museum and Hope Collection, Oxford.

Black, with basal three-fifths of the elytra red. Antennæ about three-fourths the length of the body; fifth joint angulate, each of the succeeding joints up to the tenth strongly toothed in front at the apex. Prothorax strongly and thickly punctured, with a median cariniform tubercle between the middle and the base, and a small blunt tubercle on each side of the disk nearer to the base. Elytra rather strongly punctured; the disk of each with a well-marked costa reaching from the base to within about

one-fifth from the apex. Prosternum rather strongly tuberculate between the coxæ; the mesosternum with a smaller tubercle on its hinder half.

This is the only species of the genus known to me in which the sternal processes are distinctly tuberculate.

ERYTHRUS BIAPICATUS, sp. n. (Plate XXIII. fig. 19, ♀.)

Niger, prothoracis disco et elytrorum basi rufis, nigro-vittatis: prothorace ruguloso-punctato, sine tuberculis distinctis; elytris dense granulatis, postice divaricatis, utrisque in spinam parvam terminantibus.

Long. 15½; *lat.* 3½ mm.

Hab. Kuching, Mt. Matang, 3600 ft., June 1900. One female example.

Black, with the disk of the prothorax and the basal third of the elytra partly red, the red of the prothorax being interrupted by two black bands extending from the front margin, and by a small median spot near the base, while the red on the base of the elytra is divided by a narrow band along the suture, and two wider bands on each side extending forwards and gradually narrowing from the posterior black area. Prothorax rugulose punctate, and showing traces only of the tubercles present in most of the other species. Elytra very densely granulate, the granules bearing very minute black setæ, which are scarcely evident except on the rufous areas near the base. Metasternum somewhat similarly granulate to the elytra, and the abdomen much more finely so. Antennæ of the female about half the length of the body, with the joints from the fifth to the tenth rather broad, and angulate at the apex on the anterior side.

The divergence of the elytra from the suture behind and the granulation of their surface serve to distinguish this species from all those hitherto described belonging to the genus.

ERYTHRUS VIRIDIPENNIS, sp. n. (Plate XXIII. fig. 58.)

Niger, prothorace toto rufo, elytris viridescentibus aut viridicyaneis et opacis; antennis (♂) quam corpore paullo brevioribus, (♀) medium elytrorum vix superantibus, articulis 5° ad 10^{um} modice dilatatis ad apicem dentatis; prothorace obsolete punctato, supra leviter quadri-nodoso; elytris creberrime ruguloso-punctatis, apice subsinuatis ad suturam breviter spinosis.

Long. 12-16; *lat.* 2½-3 mm.

Hab. Mount Matang, near Kuching in Sarawak (3600 ft. alt.), June 1900. Five examples; in the British Museum and Hope Collection, Oxford.

Prothorax red above and below, elytra of a dull green or bluish-green colour, all the rest of the body together with the legs and antennæ being black. Prothorax indistinctly punctured, furnished with four feeble nodules on the disk, two being near the middle and two, more widely separated from each other, near

the base. Elytra very closely rugulose-punctate, gradually widening from the base backwards, broadly rounded and slightly sinuate at the apex, with a short spine on each at the suture.

NOTHOPEUS INTERMEDIUS, sp. n. (Plate XIX. fig. 21, ♂.)

Corpore supra, capite toto, pedibus antennisque fulvis, his versus apicem infuscatis; thorace subtus et abdomine nigro-cyaneis, sed prosterno mesosternoque medio, maculis duabus metasterni et segmento primo abdominis fulvis, hoc argenteo-sericeo; elytris (quod attinet ad hoc genus) perelongatis, apicem abdominis fere attingentibus.

Long. 27; *lat.* (pone humeros) 7 mm.

Hab. Sarawak, Mt. Penrissen, May 1899. One male example; in the Sarawak Museum, Kuching.

Head, antennæ (except the last four joints, which are brownish), disk of prothorax, and elytra tawny red; body underneath bluish black, but with the prosternum, mesosternum, a spot on each side of the metasternum, and the whole of the first abdominal segment tawny, the latter being covered with a silky pubescence giving silvery reflexions in certain lights. The elytra, though unusually long for this genus, extending nearly to the apex of the abdomen, are considerably narrowed from a little behind the shoulders, and each in its posterior half is scarcely half as broad as it is at the base. The hind tibiæ of the male are thickened and subcylindrical, narrowed towards the base and very slightly also towards the distal end.

This species comes nearest in structural characters to *Aphrodisium tibiale* Rits., from Assam, but differs from it in having the elytra still more attenuated behind and the front of the head narrower. Ritsema placed his species in *Aphrodisium* as an aberrant member of that genus; but considering the reduction in the size of the elytra and the peculiar form of the male hind tibiæ, I believe it to be better placed in *Nothopeus*, though undoubtedly showing strong affinities with *Aphrodisium*. His species and the one here described are both extremely interesting as showing the gradual progress of that modification leading to the very shortened elytra and the strongly mimetic forms characteristic of the genus *Nothopeus*.

PSEBENA, gen. nov.

Head short, as broad as the prothorax; eyes finely faceted, deeply emarginate, with the lower lobes rounded, the upper very narrow; palpi short and slender. Antennæ (♀) a little longer than the body, slender, filiform; 3rd, 4th, and 5th joints subequal to one another, each twice as long as the 1st; 6th distinctly shorter than the 5th; the succeeding joints gradually diminishing in length. Prothorax subcylindrical, as broad as it is long. Elytra short, squamiform, not reaching beyond the apex of the first abdominal sternite. Prosternum narrowed behind; front coxæ prominent, their acetabula angulate outwards and

open behind. Mesosternum much broader than the prosternum; acetabula of middle coxæ open to the epimera. Metathoracic episterna rather broad in front, narrowed behind. Femora pedunculate at base, gradually thickened into a fusiform club towards the distal end. Hind legs much longer than either of the anterior pairs; first joint of hind tarsi longer than the three succeeding joints together. Abdomen normal, its intercoxal process rather broad, and obtuse in front.

This genus, which I was at first inclined to refer to Lacordaire's group *Psebiinæ*, seems to me, on fuller consideration of its characters, to be better placed in the *Necydalinæ*, although it differs from other members of this group in having no anterior prolongation of the head, the front from the interantennary ridge to the clypeal suture being relatively very short, and the clypeus scarcely broader than the labium. The *Psebiinæ* have certain characters, wanting to the present genus, which point to an affinity with the *Auxesinæ* and *Methiinæ*, and, through those groups, with the *Emineæ*.

PSEBENA BREVIPENNIS, sp. n. (Plate XIX. fig. 12, ♀.)

Capite, prothorace, elytris ad basin, articulo primo antennarum et pedibus quatuor anterioribus rufo-testaceis; metasterno medio testaceo, lateraliter fusco; abdomine medio et pedunculis femorum posticorum pallide testaceis; ceteris nigro-fuscis aut nigris.

Long. 13–16 mm.

Hab. Kuching in Sarawak, Sept. 29 and Dec. 4, 1899. Two female examples; in British Museum and Hope Collection, Oxford.

Head, prothorax, first joint of the antennæ, the four anterior legs, and the base of the elytra testaceous red. Metasternum testaceous in the middle, dark brown at the sides. Abdomen pale testaceous along the ventral surface from the base to the last segment, this segment and the lateral borders being, like the upper side, brownish black. Hind legs also black, with the femoral stalks pale testaceous or nearly white. The head and prothorax are covered with a very faint reddish pubescence, but the prothorax has two slightly raised areas on each side bare of pubescence. The inner portion of each elytron near the base is very closely punctulate and covered with a faint pubescence, the outer and apical parts being sparsely punctulate and more glossy.

3. COLEOPTERA: *Cleridæ*, by the Rev. H. S. GORHAM
and C. J. GAHAN.

CALLIMERUS CATENATUS (Gorham). (Plate XXIII. fig. 54.)

Nigro-subcæruleus, squamis albis ornatus; capite creberrime subtiliter, prothorace elytrisque parce distincte punctatis; prothorace nitido, oblongo, lateribus parum ampliatis, utrinque uni-impressis, cum marginibus anticis et posticis albo-squamosis; elytris opacis, apicibus oblique truncatis, lunulis

duabus in singulo, externe apertis, albis; pectore albo; ore, antennis, palpis pedibusque testaceis.

Long. 9 mm.

Mas? *Tibiis posticis juxta apicem denticulo acuto externe munitis.*

Hab. N.W. Borneo, Kuching.

Allied to and somewhat resembling *C. mirabilis* Gorb. Narrow, elongate, and rather smaller than the unique type of that species; clothed (including the legs) with very fine hairs. The white markings are (as in other species of this genus) composed of snow-white scales. The pattern is different from that of *C. mirabilis* in that there are on each elytron but two white lunules unconnected; each pair form an oblong X, but are scarcely joined at the suture. The apex is truncate, as in *C. mirabilis*.

A single example, apparently a male, collected Oct. 6, 1899.

TENERUS SULCIPENNIS (Gahan).

Niger; prothorace lateraliter nigro-viridescente, dimidio basali elytrorum et plaga sub-semicirculari ad basin pronoti pube rufo-velutina obtectis, dimidio apicali elytrorum atro-pubescente. Antennis articulis 3^o ad 10^{um} antice valde dilatatis, articulo 3^o quam 4^o paullo angustiore; pronoto ad medium basis paullo gibboso; elytris utrisque quadri-sulcatis, interstitiis sat latis, leviter convexis.

Long. 11; lat. 2 $\frac{3}{4}$ mm.

Hab. Kuching (March 1900). Two examples; in British Museum and Hope Collection, Oxford.

This species seems nearest allied to *T. cingalensis* White and *T. parryanus* Gorb., but differs from these and from all other known species of the genus in having the third joint of the antennæ almost as strongly dilated as the fourth, and the elytra impressed with longitudinal grooves.

4. COLEOPTERA: RHYNCHOPHORA, *Brentidae*, by Dr. A. SENNA.

DIURUS SHELFORDI Senna. (Plate XX. fig. 6, ♀.)

Moderately elongate, stoutish, black, provided with whitish scales of differing size sunk in the punctures; the head and the metarostrum with punctiform close-set scales, the joints of the antennæ clothed with long accumbent scales.

♂. Head slightly longer than broad, with the sides almost straight and a fovea between the eyes, which are prominent; the metarostrum is twice as long as the head and hardly narrowed before the antennæ; the prorostrum is short, naked, dark reddish brown. The antennæ are inserted near the apex of the rostrum: the 3rd joint is longer than the 4th, the 4th a little longer than the 5th, the 7th and 8th subequal; the three apical joints are distinct, slightly thickened and finely pubescent.

The prothorax is similarly shaped as in *D. furcillatus* (Gylh.), but comparatively broader; its upper surface is covered with

large irregular punctures, and marked on each side with a longitudinal line of rounded white scales, and in the middle with a line of small scales; moreover, punctiform scales are sunk in the punctures.

The elytra are slightly broader at the base than the prothorax in the middle, the sides are parallel, the apex is normally narrowed; they have above three narrow longitudinal costæ, the interstices between which are punctate and provided with rounded scales; the sides are foveate, each fovea shows a setiform scale; moreover, a line of rounded scales is present along the lateral margin; the outer angles of the elytra at the apex are simply toothed.

The metasternum and the base of the abdomen are covered with rounded scales; the rostrum beneath and the legs are scattered with scale-like setæ. The 3rd abdominal segment is short and contracted in the middle.

♀. Agrees with the male in all respects except the following:—The body is broader; the head short, nearly square; the metarostrum is shorter, as long as the head; the prorostrum much more elongate, longer than the metarostrum; the antennæ are inserted between the middle of the rostrum and its base; they are comparatively shorter and stouter; the 3rd abdominal segment is longer and not contracted.

Length 17–23 mm.

Hab. Kuching (N.W. Borneo).

Allied to *D. furcillatus* (Gylh.), but the new species has the head shorter and the eyes more prominent; the prorostrum is shorter; the joints of the antennæ are longer, the three apical ones more distinct; the apex of the elytra are broader and slightly toothed; the body is shorter and stouter. The female of the new species is, moreover, distinguished by the metarostrum which is shorter, and by the antennæ which are inserted before the middle of the rostrum.

I have named this species in honour of Mr. R. Shelford, who has kindly presented an interesting collection of Bornean Brentheids to the Oxford University Museum.

DIURUS SILVANUS Senna. (Plate XX. fig. 4, ♀.)

The female of this species being hitherto undescribed, I give a short description of it:—

The head is nearly square, with a fovea between the eyes; the metarostrum is short, hardly so long as the head, channelled above, and slightly narrowed before the antennæ; the prorostrum is slender, glossy, finely punctured, as long as the head and metarostrum taken together. The antennæ, which are consequently more approximate to the base than to the apex of the rostrum, are rather stout, with the 3rd joint longer than the 4th, the 6th and 7th subequal, the 8th a little shorter, the three apical joints well distinct and separate. The prothorax is strongly contracted anteriorly, the sides towards the middle are almost

parallel. The elytra are longer than twice the prothorax, narrowed at and sloping rapidly to the apex; the tails are more approximate than those of *D. furcillatus* (Gylh.); moreover, they are short and almost straight.

This species, by the shape of the elytra at the apex, is allied to *D. erythropus* (Rits.), but easily distinguished by the longer pro-rostrum, by the insertion of the antennæ being more approximate to the base of the rostrum, and by the three apical joints being well distinct and separated.

Length 30 mm. (the tails excluded).

Hab. Matang (Borneo).

EXPLANATION OF THE PLATES.

PLATE XIX.

Figures 16 to 19 are about twice the natural size: the remainder about $\frac{2}{3}$ of the natural size.

- | | |
|---|------------------------------|
| Fig. 1. <i>Tricondyla cyanea</i> (Lep.), var. <i>wallacci</i> (Thoms.). | Kuching, Feb. 1899. |
| 2. <i>Condylodera tricondyloides</i> (Westw.), mature individual. | Kuching, March 2, 1900. |
| 3. <i>Tricondyla gibba</i> (Chaud.). | Matang, Aug. 1899. |
| 4. <i>Condylodera tricondyloides</i> (Westw.), immature individual. | Kuching, Dec. 12, 1899. |
| 5. <i>Collyris sarawakensis</i> (Thoms.). | Kuching, May 14, 1900. |
| 6. <i>Condylodera tricondyloides</i> (Westw.), very young individual. | Kuching, July 18, 1900. |
| 7. <i>Pheropsophus agnatus</i> (Chaud.). | Kuching, Aug. 20, 1897. |
| 8. <i>Gryllacris</i> , n. sp. <i>vicinissima nigratæ</i> (Br.). | Sarawak. |
| 9. <i>Alcides</i> sp. | Kuching, April 20, 1900. |
| 10. <i>Issus bruchoides</i> (Walk.). | Kuching, Sept. 14, 1899. |
| 11. <i>Sclethrus amœnus</i> (Gory). | Kuching, May 14, 1900. |
| 12. <i>Psebenia brevipennis</i> (Gahan). | Kuching, Dec. 4, 1899. |
| 13. <i>Oberea strigosa</i> (Pasc.), var., from left side. | Kuching, July 26, 1899. |
| 14. <i>Oberea brevicollis</i> (Pasc.), from left side. | Kuching, March 15, 1899. |
| 15. <i>Oberea</i> , probably n. sp. near <i>strigosa</i> (Pasc.), from left side. | Matang, March 14, 1898. |
| 16. Larva of <i>Eulyes amœna</i> (Fab.), from right side. | Kuching, probably 1899. |
| 17. Larva of <i>Hymenopus bicornis</i> (Stoll), from right side. | Kuching, probably 1899. |
| 18. Larva of <i>Eulyes amœna</i> (Fab.), dorsal view. | Kuching, probably 1899. |
| 19. Larva of <i>Hymenopus bicornis</i> , dorsal view. | Kuching, probably 1899. |
| 20. <i>Salix aurosericeus</i> (Gnér.). | Kuching, July 3, 1899. |
| 21. <i>Nothopeus intermedius</i> (Gahan), ♂. | Penrisen, May 1899. |
| 22. <i>Bracon</i> sp. | Matang, Aug. 1899. |
| 23. <i>Mantispa simulatrix</i> (McLachl.). | Matang, Aug. 1899. |
| 24. <i>Polistes</i> sp. near <i>diabolicus</i> (Sauss.). | Kuching, July 27, 1899. |
| 25. <i>Mantispa</i> sp. | Kuching, July 12, 1900. |
| 26. <i>Polistes sagittarius</i> (Sauss.). | Kuching, July 2, 1898. |
| 27. <i>Mantispa</i> sp. | Matang, 3600 ft., June 1900. |

PLATE XX.

Figures 4 a, 7 a, 8 a, and 10 a are about 4 times the natural size: the remainder about $\frac{2}{3}$ of the natural size.

- | | |
|---|--------------------------|
| Fig. 1. <i>Baryrhynchus dehiscens</i> (Sch.), ♂. | Matang, Aug. 1899. |
| 2. <i>Baryrhynchus dehiscens</i> (Sch.), ♀. | Kuching, 1899. |
| 3. <i>Alibora</i> sp. | Kuching, Aug. 10, 1899. |
| 4. <i>Diurus silvanus</i> (Senna), ♀. | Matang, Aug. 1899. |
| 4 a. Left elytron of above. Dorsal view of apex, $\times 4$. | |
| 5. <i>Diurus forcipatus</i> (Westw.), ♂. | Kuching, Sept. 14, 1899. |
| 6. <i>Diurus shelfordi</i> (Senna), ♀. | Kuching, Nov. 2, 1899. |

- Fig. 7. *Egoprepis insignis* (Pasc.). Matang, Aug. 1899.
 7 a. Left elytron of above. Dorsal view of apex, $\times 4$.
8. *Stegenus dactylon* (Pasc.). Kuching, Oct. 31, 1900.
 8 a. Left elytron of above. Dorsal view of apex, $\times 4$.
9. *Dymascus porosus* (Pasc.). Kuching, July 9, 1900.
 10. *Ectatosia moerei* (Pasc.). Kuching, April 3, 1900.
 10 a. Left elytron of above. Dorsal view of apex, $\times 4$.
11. *Enidia* sp. Kuching, Feb. 1899.
 12. *Serixia prolata* (Pasc.). Kuching, Sept. 20, 1899.
 13. *Metroidea apicalis* (Jac.), var. Kuching, Aug. 1, 1899.
 14. *Entelopes*, n. sp. near *wallacei* (Pasc.). Sarawak.
 15. *Aulacophora luteicornis* (Fab.), var. Sarawak.
 16. *Tropimelopa simulator* (Pasc.). Kuching, Aug. 4, 1897.
 17. *Ochræa nigripes* (Oliv.), var. Kuching, March 28, 1900.
 18. *Astathes unicolor* (Pasc.)=*coccinea* (Pasc.). Kuching, Aug. 17, 1898.
 19. *Carithea mouhoti* (Baly). Kuching, Aug. 8, 1899.
 20. *Astathes splendida* (Fab.). Kuching, Aug. 1899.
 21. *Antipha* ? *nigra* (All.), var. Kuching, Aug. 11, 1899.
 22. *Astathes posticalis* (Thoms.). Kuching, Aug. 15, 1899.
 23. *Haplosomyx albicornis* (Wied.). Brit. N. Borneo, Sandakan, about 1895-6. A. L. Cook.
 24. *Astathes caloptera* (Pasc.)=*cyanipennis* (Thoms.). Brit. N. Borneo, Sandakan, about 1895-6. A. L. Cook.
 25. *Aulacophora boisduvali* (Baly). Kuching, Sept. 13, 1899.
 26. *Entelopes amœna* (Pasc.). Matang, Dec. 1898.
 27. *Enidia* sp. near *leta* (Baly). Penrissen, May 1899.
 28. *Chreonoma*, ? n. sp. Penrissen, May 1899.
 29. *Xylotrechus pedestris* (Pasc.). Kuching, March 28, 1900.
 30. *Cylindrepomus peregrinus* (Pasc.). Kuching, March 28, 1900.
 31. *Chlorophorus annularis* (Pasc.). Pankalan Ampat, 5-6000 ft., base of Penrissen, May 1899.
 32. *Cylindrepomus comis* (Pasc.). Kuching, March 29, 1900.
 33. *Cylindrepomus* ? form of *comis* (Pasc.). Matang, Aug. 1899.
 34. *Daphisia* sp. ♀. Matang, 3600 ft., June 1900.
 35. *Demonax viverra* (Pasc.). Penrissen, 4500 ft., May 17, 1899.
 36. *Daphisia* sp. Kuching, Aug. 4, 1897.
 37. *Clytanthus sumatrensis* (Lap. & Gor.). Trusan.
 38. *Cryllis clytoides* (Pasc.). Kuching, July 17, 1899.
 39. *Demonax mustela* (Pasc.). Pankalan Ampat, 5-6000 ft., base of Penrissen, May 1899.
 40. *Leptura* sp. Penrissen, May 1899.
 41. *Xylotrechus decoratus* (Pasc.). Penrissen, May 1899.
 42. *Leptura* sp. near *histrionica* (Pasc.). Penrissen, 4200-4500 ft., May 1899.
 43. *Chloridolum cinnyris* (Pasc.). Penrissen, May 1899.
 44. *Leptura*, ? n. sp. Matang, Aug. 1899.
 45. *Chloridolum* sp. near *thomsoni* (Pasc.). Penrissen, May 1899.
 46. *Chloridolum thomsoni* (Pasc.). Kuching, July 20, 1900.
 47. *Saperdides*, ? gen. ? sp. Matang, March 13, 1898.
 48. *Xystrocera alcjonea* (Pasc.). Kuching, Sept. 7, 1897.

PLATE XXI.

The figures are rather over $\frac{2}{3}$ of the natural size.

- Fig. 1. *Delias pandemia* (Wallace), ♂. Borneo.
 2. *Isbarta pandemia* (Rothsch.). Kina Balu Mt., Borneo, about 1896.
 3. *Delias aglaia* (Linn.), ♀. Brit. N. Borneo. Pryer, 1878-98.
 4. *Isbarta dissimulata* (Walk.). Sarawak. Wallace.
 5. *Delias cathara* (Grose-Smith). Penrissen, 3500 ft., May 19, 1899.
 6. *Callamesia (Cyclosia) pieridoides* (Walk.). Penrissen, 3500 ft., May 19, 1899.
 7. *Scrobigeria hesperoides* (Walk.). Limbang River, N. of Sarawak, April 1895. E. Bartlett.

- Fig. 8. *Eterusia obliquaria* (Walk.) Saribas, 100 miles N. E. Kuching, Nov. 1900.
 9. *Danisepa lowei* (Butl.) Brit. N. Borneo, Sandakan, about 1895-6. A. L. Cook. Kuching, Nov. 1895. Borneo.
 10. *Mimeoplæa rhadamantha* (Butl.), ♂ Kuching, Oct. 1895.
 11. *Penoa menestriesii* (Feld.), ♀ Kuching, Oct. 1895.
 12. *Mimeoplæa tristis* (Jordan), ♀ Brit. N. Borneo, Sandakan, about 1895-6. A. L. Cook.
 13. *Trepsichrois mulciber* (Cram.). Sarawak. Wallace.
 14. *Pompelon marginata* (Guér.).

PLATE XXII.

Figures 1 and 2 are about $\frac{3}{4}$ of the natural size: the remainder about $\frac{1}{2}$ of the natural size.

- Fig. 1. *Xylocopa latipes* (Drury.) Matang, March 1898.
 2. *Hyperochia fera* (v. d. Wulp.) Kuching, Feb. 1899.
 3. *Collyris emarginata* (Macl.) Mt. Serambu, Dec. 1898.
 4. *Sepedon* sp. near *javanicus* (Desv.) Mt. Serambu, Dec. 1898.
 5. *Mesostenus* sp. near *pictus* (Smith). Penrissen, May 1899.
 6. Gen. et sp. ? Fam. Stratiomyidæ, Subfam. *Raphiocerinae*. Penrissen, May 1899.
 7. *Mesostenus* sp. Pankalan Ampat, 5-6000 ft., base of Penrissen, May 1899. Penrissen, May 1899.
 8. ? *Xylophagus* sp. Kuching, Feb. 2, 1898.
 9. *Salix sericosoma* (Smith). Kuching, July 29, 1899.
 10. *Laphria* sp. near *terminalis* (v. d. Wulp.) Matang, March 13, 1898.
 11. *Macromeris violacea* (Lep.). Mt. Santubong, Aug. 1900.
 12. *Midas* n. sp. Matang, 3600 ft., June 1898.
 13. *Vespa cincta* (Fab.). Kuching, April 3, 1900.
 14. *Milesia vespoidea* (Walk.).

PLATE XXIII.

The figures are slightly reduced.

- Fig. 1. *Ectatops rubiaceus* (A. & S.). Matang, Dec. 1897.
 2. *Serinetha abdominalis* (Fab.) Botanic Gardens, Singapore, Jan. 1899.
 3. *Phanda limbata* (Wllgrn.) Botanic Gardens, Singapore, Jan. 1899.
 4. *Lycostomus gestroi* (Bourg.), ♀ Kuching, July 12, 1899.
 5. *Lycostomus gestroi* (Bourg.), ♂ Mt. Santubong, 2600 ft., Feb. 4, 1900.
 6. *Erythrus rotundicollis* (Gahan), ♂ Mt. Santubong, 2600 ft., Feb. 4, 1900.
 7. *Erythrus sternalis* (Gahan), ♂ Matang, 3600 ft., June 1900.
 8. *Erythrus apiculatus* (Pasc.), var. Matang, Aug. 1899.
 9. Rhipidoceridæ, ? gen. *Ennomates*. Matang, Dec. 1898.
 10. Eucnemidæ, ? gen. ? sp. Kuching, July 2, 1900.
 11. *Calochronus* (*Micronychus*) *dispar* (C. Waterh.), ♀. Matang, Aug. 1899.
 12. *Pyresthes virgata* (Pasc.) Matang, 3600 feet, June 1900.
 13. *Eurycephalus lundii* (Fab.) Kuching, May 7, 1900.
 14. *Tenerus sulcipennis* (Gahan). Kuching, March 14, 1900.
 15. *Goniophora wallacei* (Baly), var. Kuching, May 28, 1900.
 16. *Metriorrhynchus kirschi* (C. Waterh.), ♂ Kuching, Aug. 15, 1899.
 17. " " (C. Waterh.), ♂ Kuching, May 28, 1900.
 18. *Ephies dilaticornis* (Pasc.), var. ♂ Matang, 3600 ft., June 1900.
 19. *Erythrus biapicatus* (Gahan), ♀ Matang, 3600 ft., June 1900.
 20. *Agonischius* ? *sanguineipennis* (Cand.) Kuching, May 16, 1900.
 21. *Agonischius pectoralis* (Cand.) Kuching, May 16, 1900.
 22. Reduviid sp. Sarawak.
 23. *Melampyrus acutangulus* (Bourg.), ♂ Matang, Aug. 1899.
 24. *Cautires excelsus* (C. Waterh.), ♀ Kuching, Sept. 6, 1899.

- Fig. 25. *Xyaste fumosa* (Pasc.). Kuching, March 23, 1900.
 26. *Xyaste invida* (Pasc.). Kuching, July 10, 1899.
 27. *Gonophora wallacei* (Baly). Kuching, Aug. 1897.
 28. *Taphes brevicollis* (C. Waterh.), ♀. Kuching, Jan. 24, 1900.
 29. *Ditoneces* sp. near *fuscicornis* (Gorh.). Kuching, Sept. 6, 1899.
 30. *Caria dilatata* (Fab.). Matang, March 13, 1898.
 31. *Prioptera octopunctata* (Fab.). Sarawak.
 32. *Entelopes glauca* (Guér.). Penrisen, May 1899.
 33. *Blachia ducalis* (Walk.). Kuching, Dec. 13, 1900.
 34. Locustid of new genus near *Gammarotettix*. Kuching, Feb. 2, 1901.
 35. *Lema quadripunctata* (Oliv.). Kuching, Oct. 12, 1899.
 36. *Apoderus javanicus* (Jekel). Kuching, April 4, 1900.
 37. Pterophorid, probably near genus *Coremagna*. Kuching, Jan. 16, 1901.
 38. *Bracon* sp. Kuching, April 24, 1900.
 39. Homopteron of genus probably near *Brixia*. Kuching, Jan. 17, 1901.
 40. *Epania singaporensis* (Thoms.). Penrisen, May 1899.
 41. *Melipona vidua* (Lepel.). Kuching, May 8, 1900.
 42. Capsid sp. Kuching, June 22, 1900.
 43. *Holocephala* ? *hirsuta* (v. d. Wulp). Kuching, May 3, 1900.
 44. *Megalocolus notator* (Walk.). Kuching, April 24, 1900.
 45. Reduviid sp. Kuching, Sept. 16, 1899.
 46. *Torophora*, n. sp. near *javana* (Wied.). Kuching, May 16, 1900.
 47. *Bracon* sp. Kuching, Aug. 11, 1900.
 48. *Mutilla* sp. near *urania* (Smith). Kuching, July 17, 1899.
 49. *Tillicera*, n. sp. ? near *T. bibalteata* (Gorh.). Kuching, Aug. 1899.
 50. *Cladophorus atrofuscus* (C. Waterh.), ♀. Kuching, March 15, 1900.
 51. " " (C. Waterh.), ♀. Kuching, April 14, 1900.
 52. *Tenerus sulcipennis* (Gahan). Kuching, March 30, 1900.
 53. *Callimerus bellus* (Gorh.). Kuching, Dec. 13, 1899.
 54. *Callimerus catenatus* (Gorh.). Kuching, Oct. 6, 1899.
 55. *Daphisia pulchella* (Pasc.). Kuching, June 19, 1900.
 56. *Spathomeles*, n. sp. near *S. turritus* (Gerst.). Kuching, Oct. 15, 1897.
 57. *Zelota spathomelina* (Gahan). Kuching, Dec. 12, 1899.
 58. *Erythrus virilipennis* (Gahan). Matang, 3600 ft., June 1900.
 59. *Prionocerus caeruleipennis* (Perty). Kuching, May 4, 1900.
 60. *Tetralanguria pyramidata* (Fab.). Kuching, Dec. 8, 1899.
 61. *Botryonopa cyanipennis* (Baly). Kuching, Feb. 24, 1899.

2. On the Classification of the Fishes of the Suborder Plectognathi; with Notes and Descriptions of new Species from Specimens in the British Museum Collection. By C. TATE REGAN, B.A.¹

[Received September 26, 1902.]

(Plates XXIV. & XXV.² and Text-figures 56-59.)

PART I.—CLASSIFICATION.

In the systematic account which follows are embodied the results of a study of the Plectognathous fishes, and especially of their osteology, which I have made. The numerous characters of importance which have hitherto been overlooked or misunderstood by ichthyologists will serve as an apology for the present paper. My sincere thanks are due to Mr. Boulenger for criticism and suggestions, which his wide experience has made invaluable.

The Plectognathi are here treated of as a distinct suborder, as

¹ Communicated by G. A. BOULENGER, V.P.Z.S.

² For explanation of the Plates, see p. 303.